INSTRUCTION MANUAL

SULTAN

Acoustic Wave Series

- Level, Flow, Positioning, Collision Protection -

A higher level of performance

HAWK

CONTENTS

PROPRIETARY NOTICE

The information contained in this publication is derived in part from proprietary and patent data. This information has been prepared for the express purpose of assisting operating and maintenance personnel in the efficient use of the instrument described herein. Publication of this information does not convey any rights to use or reproduce it, or to use for any purpose other than in connection with the installation, operation and maintenance of the equipment described herein.

WARNING

This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the removal, installation, or handling of internal circuit boards or devices:

Handling Procedure:

1. Power to unit must be removed prior to commencement of any work.

2. Personnel must be grounded, via wrist strap or other safe, suitable means, before any printed circuit board or other internal devices are installed, removed or adjusted.

3. Printed circuit boards must be transported in a conductive bag or other conductive container. Boards must not be removed from protective container until the immediate time of installation. Removed boards must be placed immediately in a protective container for transport, storage, or return to factory.

Comments:

This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, CMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

GENERAL DESCRIPTION

FEATURES

The Sultan series is a range of leading edge level instruments using Hawk's Acoustic Wave technology. The range includes simple and also full featured level and position transmitters and switches. Functions are included for basic level or position measurement, vessel linearisation, differential or average level using two sensors, and open channel flow calculation. Flexible design allows operation from a range of power supply configurations including two wire loop power systems. Various digital communications protocols are supported as options.

Principle of Operation

A **SULTAN 234 Series** sensor transmits a high powered acoustic wave pulse, which is then reflected from the surface of the material or target to be measured.

Reflected signals are processed using highly developed algorithms to enhance the correct signal and reject false or spurious echoes.

The transmission of high powered, low frequency waves ensures minimal losses through the environment where the sensor is working. The high initial energy of the pulse, at penetrating low frequencies, ensures that any signal losses which do occur have far less negetive effect than would be experienced by traditional ultrasonic devices.

The sensitive receiver circuitry of the Sultan series is designed to identify and monitor low strength return signals even when combined with high noise levels.

Measured signals are temperature compensated to provide maximum accuracy of the outputs and display.

- The **SULTAN 234 Series Acoustic Wave Range** offers a wide and comprehensive range of advantages
- Large selection of transducers
- Self cleaning transducers
- No contact between the transducer and the material
- Suitable for measuring rocks, powders, viscous and aggressive media
- Power supply flexibility allows for 2 wire loop power, AC and DC supplies all within a single amplifier
- Easy to calibrate and commission
- Wide spectrum of applications.
- Multiple head capability to reduce cost per unit (max 128 points)
- Open channel flow
- Differential Level
- Crane / positioning
- Average of 2 inputs
- Transducer cross talk prevention

TYPICAL APPLICATIONS

SOLID PRODUCT LEVEL
High / Low / Continous
Granular / Powder
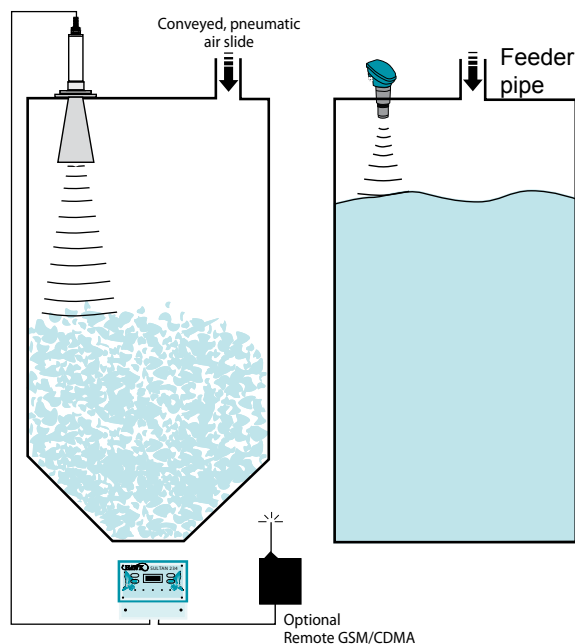
LIQUID PRODUCT LEVEL
High / Low / Continous
Liquid / Chemical /Slurry

Conveyed, pneumatic
air slide

Feeder
pipe

IP68
sensor

Flood
Hood

Optional
Remote GSM/CDMA

Remote
Amplifier

or

Panel Mount

APPLICATION REFERENCE

Reliable acoustic wave level technology for water treatment plants, for monitoring sand filter bed tanks

Application problem:
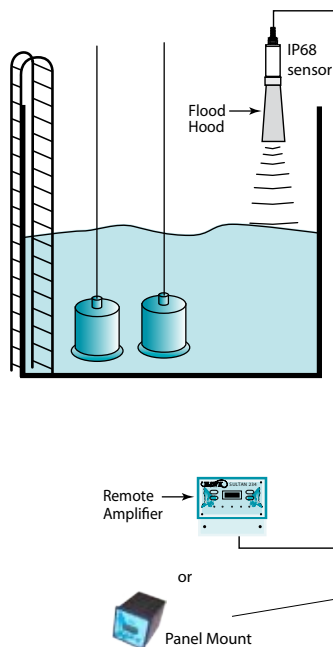The customer had used conductivity probes to control high and low level water in their sand filter tanks. The probes were a problem because the coated up with slime and required routine cleaning.

Solution:
Hawk installed **Sultan Acoustic Wave**, 2 wire loop powered 20kHz transmitter. The lower frequency 20kHz transducer provided excellent reliable control, during all sequences of the sand filter process. Maximum range of the 2 wire 20kHz transmitter is 20 m (65 ft). When the sand filter was drained the instrument had no trouble monitoring the sand and the backwash sequence, which the client could not achieve with the conductivity probes.

Using the 20 kHz frequency transmitter, provided a solution to cover all environment changes, including rain, fog, snow, condensation, some frothing during back wash etc.

Hawk manufactures the largest range of acoustic wave, 2 wire loop powered transmitters in the world, to suit all applications.

Note: Remote mounted transmitters, for the 2 wire loop powered range can be mounted up to 700 m (2300 ft) from the transducer, using belden 3084A cable.

Ordering information: (complete system)
Part no integral version:
AWI2SB20T4XXXX-FA4A-4-C04
Part no remote version: AWR2SBXXXX-
AWRT20T4XXXC6-FA4A-4-CO4-4

APPLICATION REFERENCE

Reliable level technology for coal surge bins

Application problem:
The client had been looking for a reliable level technology, to monitor level, in two 35 metre coal surge bins, that fill and empty simultaneously.

Comments:
The client tried radar, from the three major suppliers. The problem was that over a long range (35 m), the beam angle of the radar transmitters was too wide. The radar system became unreliable beyond 20 metres. The radar also suffered with build up in the focalizer cone, requiring cleaning on a periodic basis.

Solution:
The new acoustic wave level transmitter was installed and worked reliably over the full range of the 35 m silo, during filling and emptying operations. The active pulse generated by the acoustic wave transducer produced self cleaning.

Ordering information:
Part number: AWRT10T4XXXC15XX + FA10A-4 + C10-10-4 / AWR234SUXXXX

APPLICATION REFERENCE

Coal Mine

Aerial conveyor tripper control

(This type of control can be applied to all types of tripper conveyer for optimizing stockpile bunker levels and also providing protection for blockages etc.)

Application Problem:
The client wanted to optimize the stockpile height and automate the movement of the tripper conveyer. The client also wanted block chute detection for the coal feeder chutes. The level transmitters also allowed the control room to see the stockpile profile for inventory control.

Solution:
The best technology solution for the level transmitters was acoustic wave. The low frequency acoustic transmitter had a maximum range of 100 metes and a very narrow beam angle. Transducers were mounted on either side of the tripper conveyer feeder chutes. High speed response of the transmitters allowed for profile control. The blocked chute control for the feeder chutes and transfer chute of the conveyor used the Gladiator microwave switches which have a pre-test function and are non intrusive.

Both the Sultan acoustic transmitters and the Gladiator microwave switches have totally fail-safe capability.

For more application details contact the factory - contact details below.

Ordering information: (complete system)
2 x AWRT10S4XXXC15 + AWR234SUXXX + Flange/Cone
3 x GSASUS + GMSB + GMRR

APPLICATION REFERENCE

Reliable level technology for liquid tanks in water treatment plants

Application Problem:
Clients require reliable technology for measurement of liquid levels in a variety of tank sizes and styles. Continuous, switch point and communication options are all at times required by different control systems. Typical liquid tank applications are chemical storage tanks, day tanks and dosing and mixing tanks.

Comments:
Smaller sized (1-5m), calm liquid tanks are well suited to the compact high frequency Sultan Integral (all in one) Acoustic Wave product, using 2" BSP/NPT mounting. More general applications with condensing vapour, or foaming surfaces, agitation or over a little longer range (1-10m), will only be reliable using slightly stronger, lower frequency (20kHz) sensors, able to self clean with every high energy measuring pulse, mounted using Hawk's recommended flange and cone.

Solution:
Hawk provides Integral (all in one) and Remote (separate transmitter and transducer) products from our Sultan Acoustic Wave range, giving reliable, continuous and switch point solutions for liquid tank level measurement, compatible with a variety of power supply and control output requirements.

Ordering information:
Integral unit- small tank:
AWI234SU30T6TB20XXX

Remote system- liquid tank:
AWR234SUXXXX
AWRT20T4XXXC6XX
FA4A-4 + C04-4

DIMENSIONS

INTEGRAL UNITS

Standard Flanged Type

Compact Type
(2"BSP/NPT)
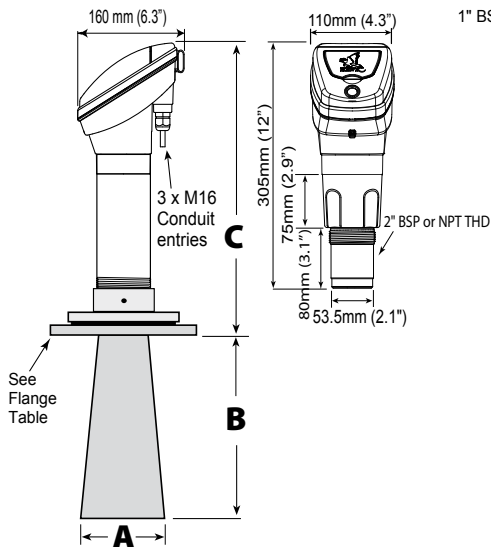
SMART UNITS AND REMOTE TRANSDUCERS

Standard Flanged Type

Compact Type
(2"BSP/NPT)
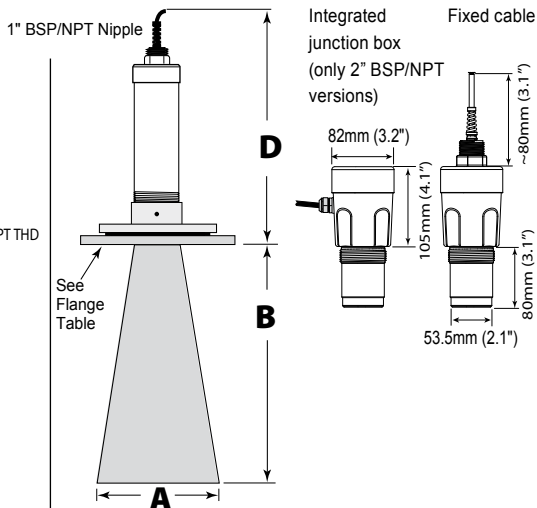
All horns must protrude into the main volume of the vessel by at least 50 mm (2 inches) past the lower end of the mounting nozzle.

Dimensions Table								
Sensor Frequency	Selected Flange	A mm	in	B mm	in	C mm	in	D mm	in
5 kHz	10"	236	9.2	455	17.9	840	33.1	750	29.5
10 kHz	10" 8"	236 195	9.2 7.6	415 280	16.3 11.1	540 540	21.3 21.3	450 450	17.7 17.7
15 kHz	10" 8"	236 195	9.2 7.6	455 280	17.9 11.0	440 440	17.3 17.3	350 350	13.8 13.8
20 kHz	4"	98.5	3.9	280	11.0	390	15.4	300	11.8
30 kHz	4"	98.5	3.9	280	11.0	350	3.8	260	10.2

DIMENSIONS
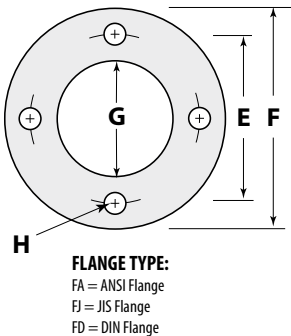
STANDARD ANSI/DIN/JIS FLANGE DIMENSIONS

SIZE	FLANGE TYPE	E (PCD) mm	E (PCD) in.	F(OD) mm	F(OD) in.	G (ID) mm	G (ID) in.	H (Hole) mm	H (Hole) in.
4"	FA4	190.5	7.5	228	9.0	100	4	19	0.75
	FD4	180	7.0	220	8.7	100	4	18	0.7
	FJ4	175	6.9	210	8.4	100	4	15	0.6
10"	FA10	362	14.3	406	16.0	250	10	25	1.0
	FD10	350	13.8	395	15.6	250	10	22	0.85
	FJ10	355	14.0	400	15.7	250	10	23	0.9
8"	FA8	298.5	11.8	343	13.5	200	8	22	0.85
	FD8	295	11.6	340	13.4	200	8	22	0.85
	FJ8	290	11.4	330	13.0	200	8	19	0.75

Note: Other flange sizes available upon request.

FLANGE TYPE:
FA = ANSI Flange
FJ = JIS Flange
FD = DIN Flange

REMOTE AMPLIFIERS

Field Mount
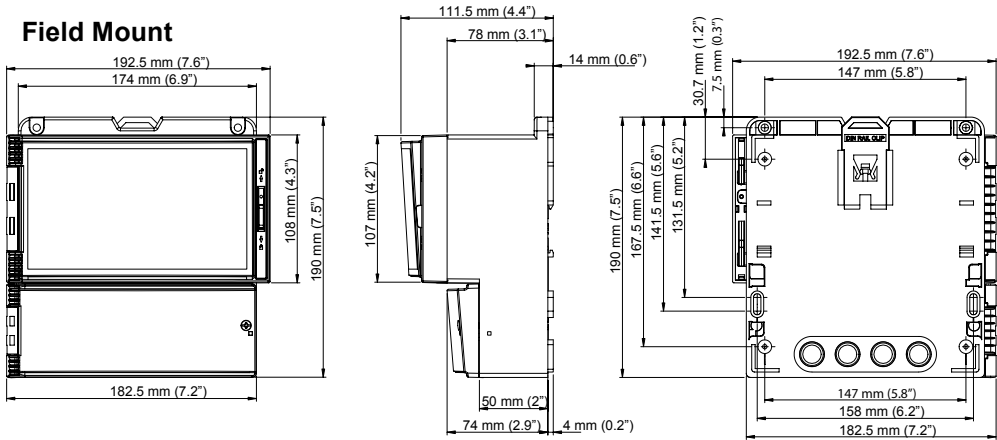
Panel Mount - cut out size 90x90mm (3.54x3.54")

Front

Back

Side

Allow clearance for securing clamp screws.

Allow clearance for wiring here
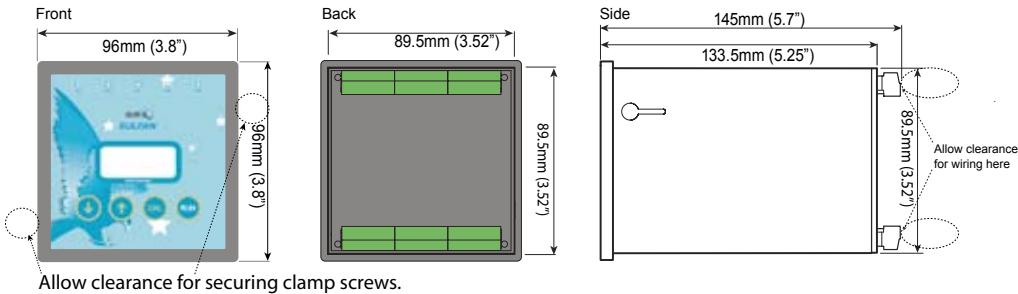
MOUNTING DIMENSIONS

2 INCH BSP/NPT THREADED NOZZLE MOUNTING

2" Pipe Dimensions (OD 60.3mm)	ID (mm)	Thickness (mm)
Schedule 5 - 5/ /5S	57.0	1.65
Schedule 10 - 10/ /10S	54.8	2.77
Schedule 30 - 30	54.0	3.18
Schedule 40 - 40/SYD/40S	52.5	3.91

20mm (0.79")

Ensure the face of the sensor protrudes into the vessel by more than 20mm
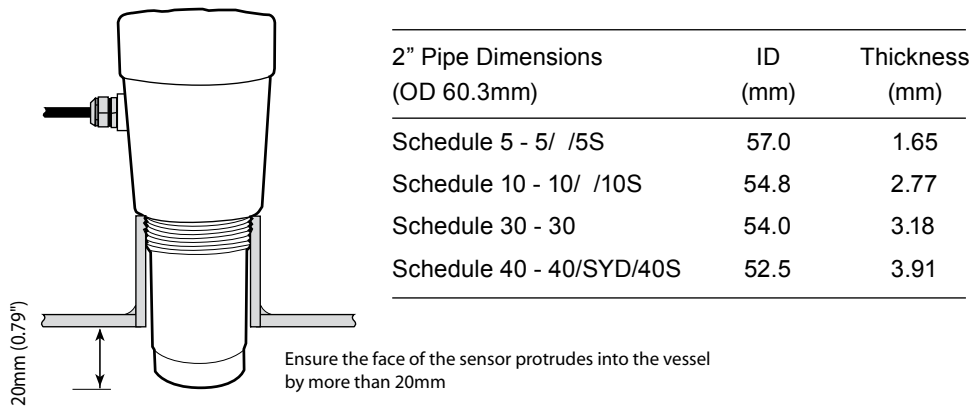
NOZZLE MOUNTING FOR SENSORS WITH FLANGE AND CONE

A

B

C

Roof of Tank
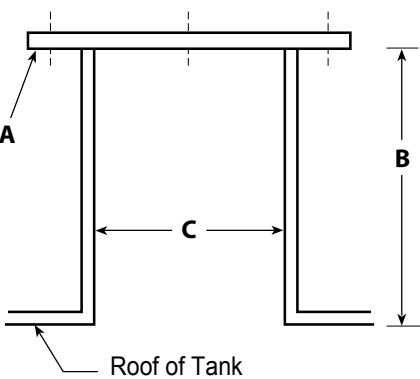
NOZZLE MOUNTING DIMENSIONS		
A	**B**	**C**
100mm (4in) DIN, ANSI, JIS	240mm 9.44in	100mm 4in
150mm (6in) DIN, ANSI, JIS	240mm 9.44in	150mm 6in
200mm (8in) DIN, ANSI, JIS	300mm 11.80in	200mm 8in
250mm (10in) DIN, ANSI, JIS	390mm 15.35in	250mm 10in

TYPICAL INSTALLATIONS

Conical Shape Vessels
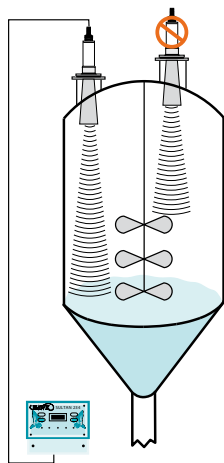
Horizontal Cylindrical Tanks
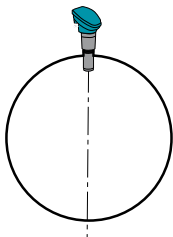
Stockpiles, Stackers, Reclaimers

BLANKING DISTANCE TABLE

BLANKING DISTANCE TRANSDUCER FREQUENCY		Minimum	Nominal	Conservative
AWRT50	50kHz	0.25m (10")	0.3m (1ft)	0.35m (1.2ft)
AWRT40	40kHz	0.3m (1.1ft)	0.35m (1.2ft)	0.4m (1.4ft)
AWRT30	30kHz	0.35m (1.5ft)	0.4m (1ft)	0.5m (1.6ft)
AWRT20	20kHz	0.5m (1.6ft)	0.6m (2ft)	0.8m (2.6ft)
AWRT15	15kHz	0.6m (2ft)	0.7m (2.2ft)	1.0m (3.9ft)
AWRT10	10kHz	1.0m (3.3ft)	1.1m (3.5ft)	1.3m (4.2ft)
AWRT5	5kHz	1.2m (3.9ft)	1.4m (4.6ft)	1.5m (5ft)

Always use conservative nominated distances if possible

INSTALLATION GUIDE

AMPLIFIER - FIELD MOUNT

Select a suitable mounting position that is not in direct sunlight. If necessary, utilize a sunshade. Observe the minimum and maximum temperature limits (-20°C/-4°F to 60°C/140°F) Do not mount near sources of high E.M.F. such as high current cables, motor starters, or S.C.R. variable speed drives. Avoid mounting in high vibration areas such as handrails and rotating plant. Use rubber absorption mounts if mounting in light vibration areas. Remove the P.C.B. assembly before knocking out the cable and conduit entry holes.

AMPLIFIER - PANEL MOUNT

- Select a suitable position within a panel layout which allows clearance arround the outside of the front panel of the unit.
- Ensure that sufficient space is available behind the panel to accommodate the depth of the amplifier housing, and also allow cabel bend clearance for wiring to the terminals on the rear of the amplifier.
- Mark and cut a 90x90mm (3.54x3.54") square cut out throught the panel in the disired position.
- Insert the Sultan amplifier throught the panel and install supplied screw clamps into the slotted holes in the amplifier housing. Tighten the screws until just firm to secure the amplifier i place.
- Connect wiring as required to the corect terminals on the removable rear panel connectors. *When plugging connectors in to the rear panel, ensure that they are re-installed in the correct position (upper or lower).

BLANKING DISTANCE

Where possible use the conservative values and increase this distance by 50% if there is foam, dust, steam, or condensation in the vessel being monitored. *(refer to table on previous page.)* If using a flange mounting, use a rubber or neoprene gasket and washers. If using a nipple mounting, ensure that the mounting bracket is **>6mm (0.24 in) from the rear** of the transducer. Do not over tighten the lock nuts. When using a focaliser cone, ensure that it protrudes at least 50mm (2 in) into the vessel. If the transducer needs to be mounted above the roofline, use an appropriate standpipe or nozzle.
Use common sense when selecting the mounting position. A clear line of sight from the transducer to the product being monitored is preferred.

TRANSDUCER

Selecting a suitable position to mount the transducer on the vessel is the single **MOST IMPORTANT** step. Please read all of the installation guide and contact your Hawk representative if you have any doubts or questions. The transducer face **MUST** be at least the blanking distance away from highest product level in the bin, tank, or silo at all times. *(refer to table below.)*

MONITORING SOLIDS

In general, the transducer mounting position can be determined by measuring the distance from the infeed to the vessel wall, and mounting the transducer l/3r this distance from the wall. *(refer diagrams pages 11, 13, 15.)*

INSTALLATION GUIDE

MONITORING LIQUIDS

Mount the transducer perpendicular to the liquid surface and away from the infeed.

Avoid mounting near ladders, baffles, agitators etc.
(refer to Typical Applications)
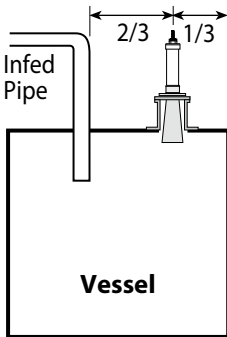
MOUNTING POSITION   **NOZZLE MOUNT**   **FLUSH MOUNT**   **STAND PIPE MOUNT**
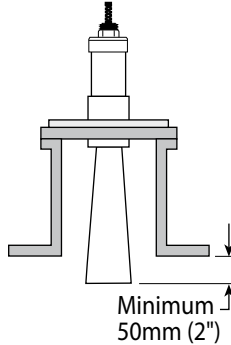
2/3   1/3

Infed Pipe

Vessel

Minimum 50mm (2")

Minimum 50mm (2")
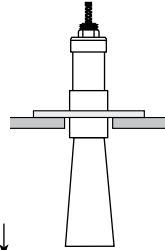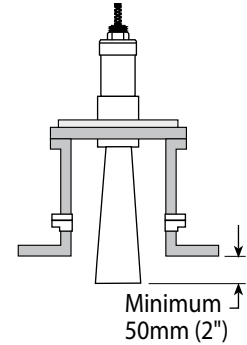
TRANSDUCER MOUNTING

SOLID (Granular)   **LIQUID**   **DUAL OUTFEED**   **POWDER**
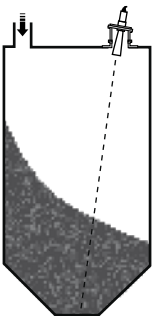
Aim transducer at point of outfeed.

Transducer should be as perpendicular to product as practicable.
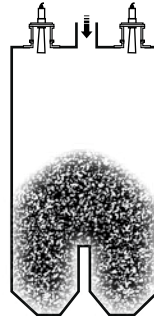
Use two transducer and select sequence option to avoid cross-talk.
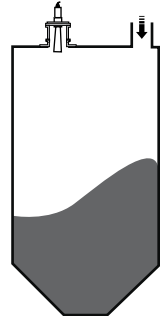
Mount away from infeed

INSTALLATION GUIDE

TRANSDUCER MOUNTING

2" VERSION

Correct

Vessel roof

min 20mm inside tank
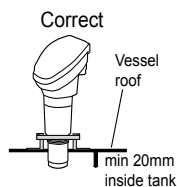
Hawk recommends a focaliser cone for all transducers as they are designed specifically to increase the acoustic performance of the Sultan product range.
Hawk supplies a variety of cones for all Sultan Transducers.
Threaded mounting should only be used where a flange/cone mounting is impossible.

Incorrect

Intrusive pipe

Non preferred

Intrusive pipe
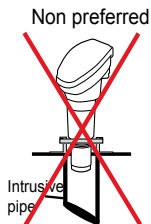
Bevel pipe end at 45 degrees

If a stand pipe MUST be used ensure a 45º angle is cut to minimise echo return from the end of the pipe. You may need to increase the Blanking parameter to avoid seeing an incorrect return echo from the end of the pipe.

INSTALLATION GUIDE

VERTICAL LIQUID TANK APPLICATIONS

50mm (2") Min

R

+/-1/4 to 1/3R
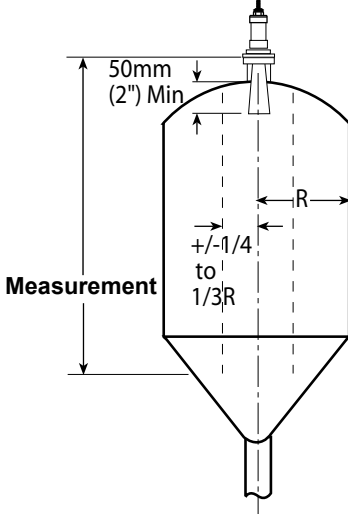
Measurement

Mount in the center part of the tank

Measurement will be from transducer or flange face to point directly below transducer in vessel.

Ensure transducer is perpendicular to liquid surface at all times.

HORIZONTAL LIQUID TANK APPLICATIONS

Measurement

50mm (2") Min

+/-1/4 to 1/3R

R

End View

Alternate

+/-1/4 to 1/3R

Preferred

R

Alternate

Top View

AGITATED LIQUID TANKS

Avoid mounting over agitator if possible

50mm (2") Min

R

Measurement

Center Transducer between → Blade and Tank Sidewall
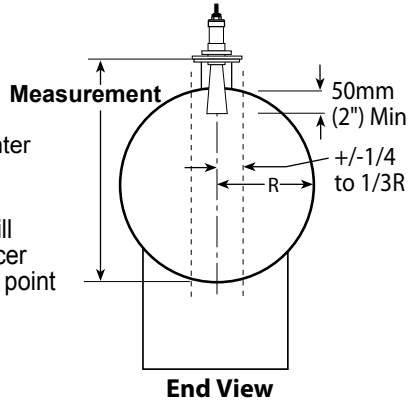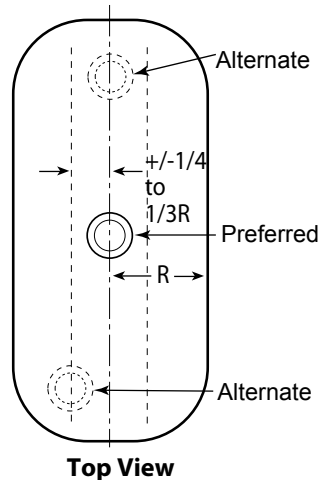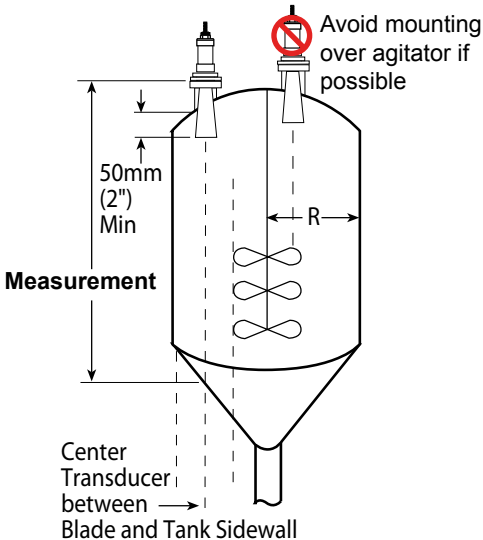
OPEN CHANNEL FLOW MEASUREMENT PRINCIPLES

MOUNTING WEIR
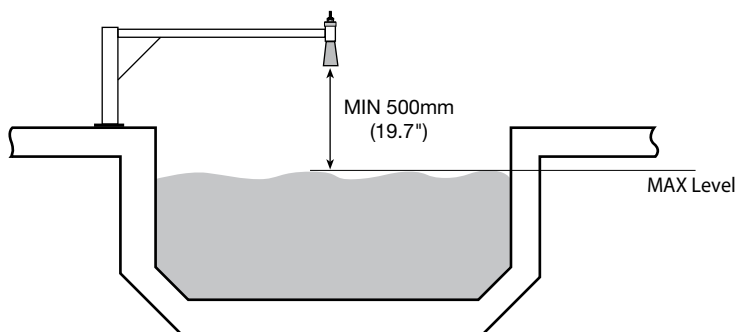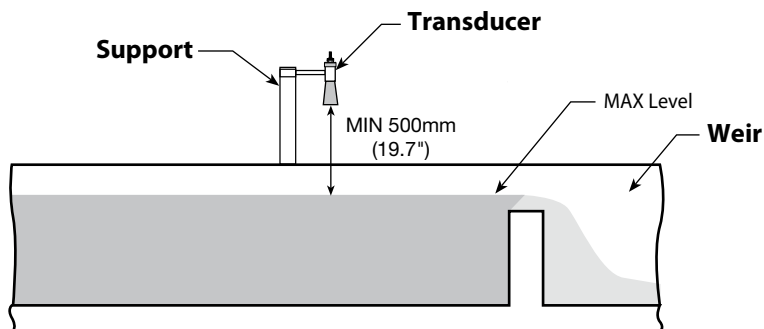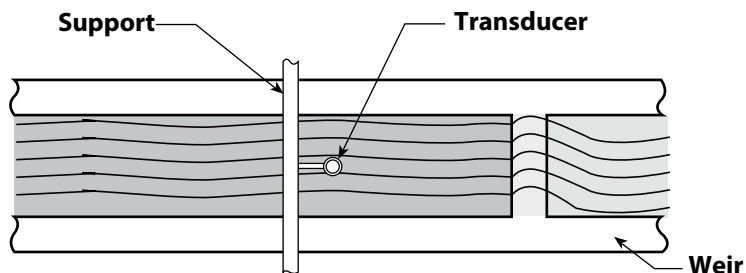
OPEN CHANNEL FLOW MEASUREMENT PRINCIPLES

MOUNTING

PARSHALL FLUME

submerged flow

free flow

RECTANGULAR FLUME

Overall edge

$4 \times h_{max}$

90°

≥ 5cm

Upstream
Water

Downstream
Water
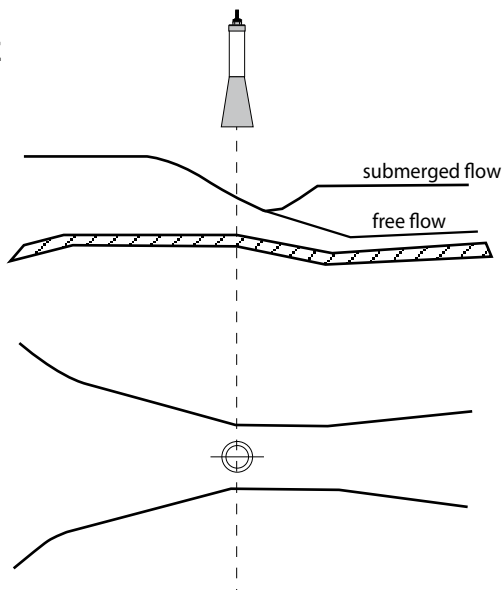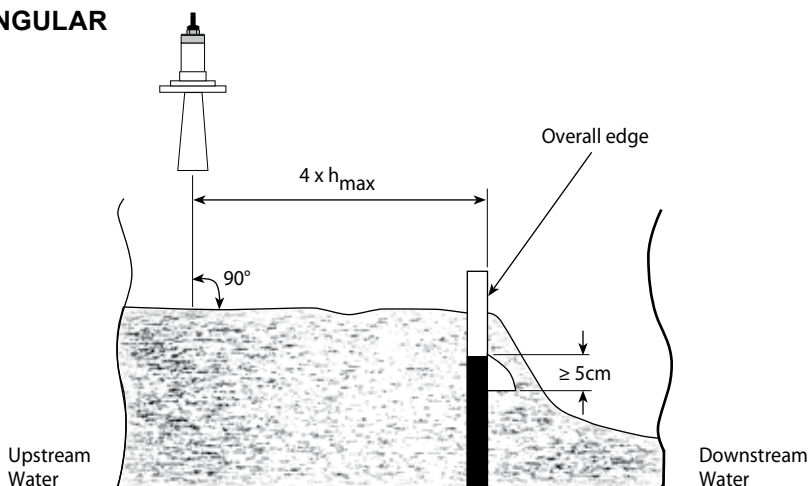
WIRING

TERMINAL LAYOUTS
Sultan SMART Models

AWSTD

Outputs

- 4-20mA
- Relay
- Modbus Multidrop

RELAY   COMMS   DC-in   4-20mA

| BWN | COM | ORG | NO | PPL | Test in | WT | A | BLU | B | BLK | - | RD | + | GRN | - | YEL | + |

RELAY   RS - 485   4-20mA current sinking

24 Vdc
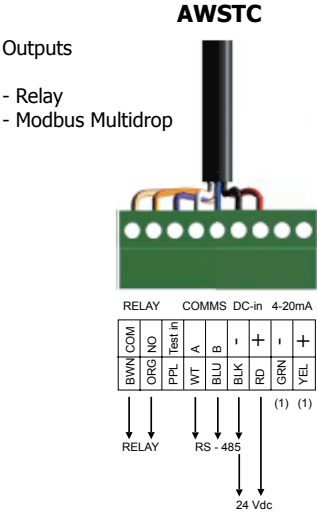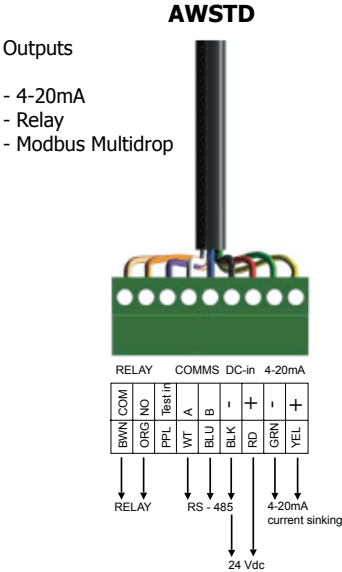
For cable only models (without integrated junction box option), please use colors shown to denote wire functions.

AWSTC

Outputs

- Relay
- Modbus Multidrop

RELAY   COMMS   DC-in   4-20mA

| BWN | COM | ORG | NO | PPL | Test in | WT | A | BLU | B | BLK | - | RD | + | GRN | - | YEL | + |

(1) (1)

RELAY   RS - 485

24 Vdc
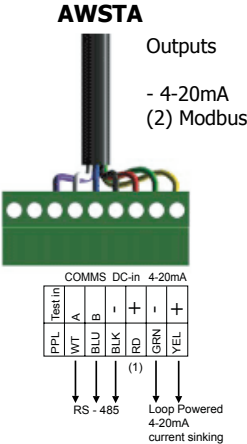
For models with integrated junction box option, remove plug-in terminal blocks for easier wiring.

AWSTA

Outputs

- 4-20mA
(2) Modbus

COMMS   DC-in   4-20mA

| PPL | Test in | WT | A | BLU | B | BLK | - | RD | + | GRN | - | YEL | + |

(1)

RS - 485   Loop Powered 4-20mA current sinking

Notes:

(1) - No internal connection
(2) - Single Modbus connection PC to unit only
     Multidrop connection not recommended

WIRING

TERMINAL LAYOUTS

Sultan 234 Models
AWI234 Series Transmitter
Integral Version (2 Relays)

RELAY 1			COMMS			RELAY 2		
NC	COM	NO	A	B	Shld	NC	COM	NO
⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
L1	N	⏚	−	+	Is	Test	−	+
AC-IN			4-20mA				DC-IN	

90-260 VAC

Modulating
4-20mA from
PLC input

Driving 4-20mA from Sultan to user PLC
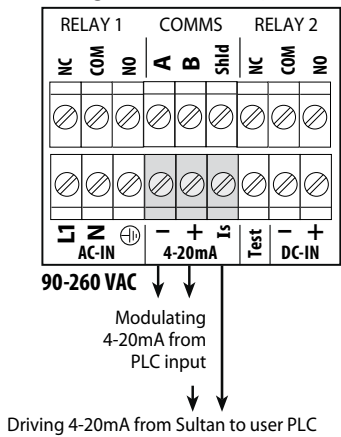
AWR234S Series Transmitter
Remote Field Mount (5 Relays)

RELAY 1			RELAY 2			RELAY 3			RELAY 4			RELAY 5		
NC	COM	NO	NC	COM	NO	NC	COM	NO	NC	COM	NO	NC	COM	NO
⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
4-20mA			TRANSDUCER			COMMS			DC-IN			AC-IN		
⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
Is	+	−	RED	BLACK	BLUE	WHITE	Test in	B	A	−	+	⏚	N	L1
4-20mA													90-260 VAC	

Modulating 4-20mA
from PLC input

Driving 4-20mA from Sultan to user PLC
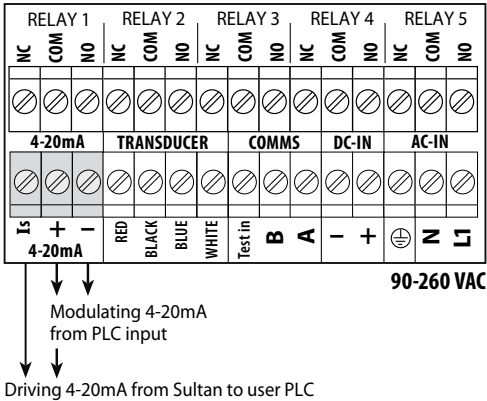
AWR234P Series Transmitter
Remote Panel Mount (5 Relays)

	RELAY 1			RELAY 2			RELAY 3			RELAY 4			RELAY 5		
	NC	COM	NO	NC	COM	NO	NC	COM	NO	NC	COM	NO	NC	COM	NO
Top Row	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
	AC-IN			DC-IN		COMMS		TRANSDUCER				4-20mA			
Bottom Row	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
	L1	N	⏚	+	−	A	B	Test in	WHITE	BLUE	BLACK	RED	−	+	Is
	90-260 VAC												4-20mA		

Modulating 4-20mA
from PLC input

Driving 4-20mA from Sultan to user PLC
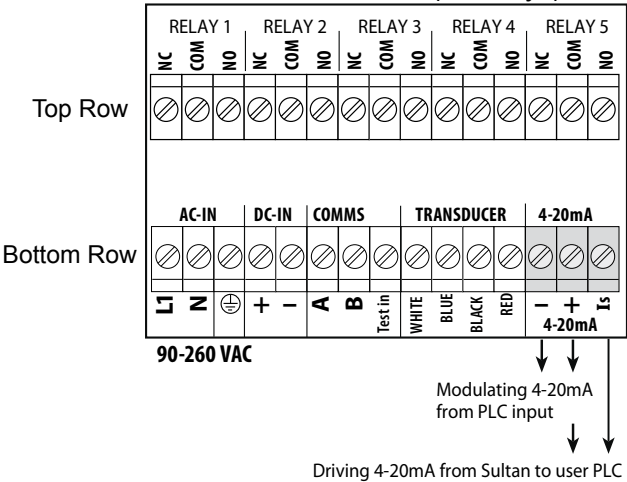
WIRING

Sultan 2 Models
AWI2 Series Transmitter
Integral Version

COMMS		
A	B	SHLD
⊘	⊘	⊘
4-20mA		
⊘	⊘	⊘
−	+	TEST
4-20mA		
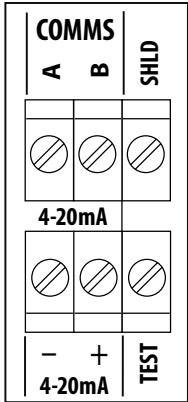
Modulating 4-20mA
from PLC input

AWR2S Series Transmitter
Remote Field Mount

TEST	⊕	COMMS		SHLD	SHLD
		A	B		
⊘	⊘	⊘	⊘	⊘	⊘
TRANSDUCER				**4-20mA**	
⊘	⊘	⊘	⊘	⊘	⊘
RED	BLACK	BLUE	WHITE	+	−
				4-20mA	
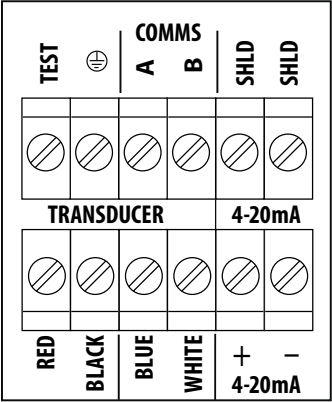
Modulating 4-20mA
from PLC input

AWR2P Series Transmitter
Remote Panel Mount

Bottom Row

					COMMS			TRANSDUCER				4-20mA		
⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
N/C	N/C	N/C	N/C	−	A	B	Test in	WHITE	BLUE	BLACK	RED	−	+	N/C
												4-20mA		
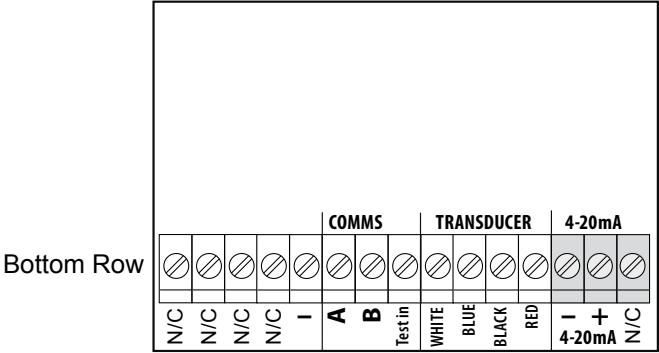
Modulating 4-20mA
from PLC input

WIRING

REMOTE TRANSDUCER CONNECTION

Direct Connection to Transducer Cable

Sultan Remote Amplifier

TRANSDUCER

RED BLACK BLUE WHITE
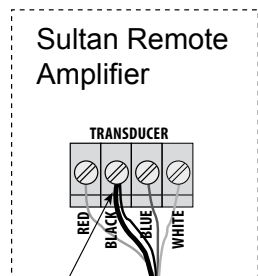
Connect Cable Shield to Black

Note: Terminal order varies with different model types, see terminal layouts page 21, 22.

All cable shields connect to **BLACK WIRE** at transmitter end

TRANSDUCER

TRANSDUCER

Connection via Junction Box and Extension Cable

Sultan Remote Amplifier

TRANSDUCER

RED BLACK BLUE WHITE
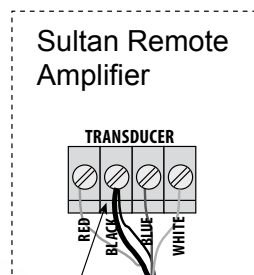
Re-connect Cable Shield to Black

Cable Shield

OPTIONAL JUNCTION BOX

(for cable extension)

RED BLACK BLUE WHITE SHIELD

Seperate Black/Shield

"USE ONLY"
BELDEN 3084A
DEKORON IED183AA002
to extend transducer cable
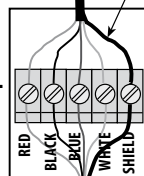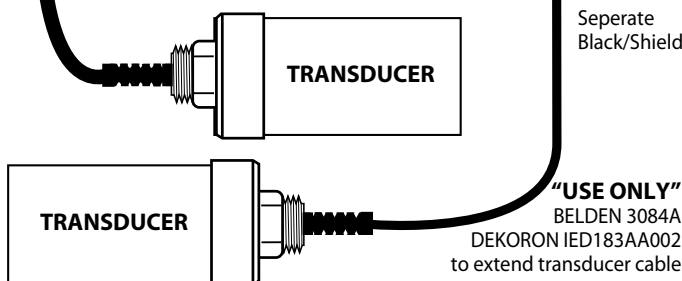
*When extending transducer cable using DEKORON shielded twisted pair cable types, ensure that one pair is used to extend Blue and White, and another pair is used to extend Red and Black.

WIRING

4-20mA Output Connection
Terminal Connections for AC Powered Operation
234 models with AC power option and SIM card positioned for 3/4 wire mode

a) 5 Wire – Driving from Internal Isolated Supply (Is)

NOTE:
Isolated current output can be made common with external DC Supply Positive or Negative if required.
(e.g. RL – connected to GND)

90 - 260Vac Supply

SULTAN Terminal Connection

L1
N

AC Supply

+
−
PLC
DCS
IND
RL Max 270Ω
4-20mA

Use shielded cable

−
+
Is

4-20mA

Sultan output is sourcing current and provides voltage to drive a passive load, PLC input or indicator.
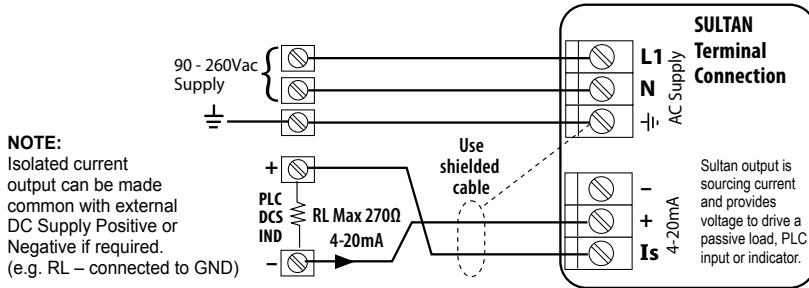
b) Modulating from User's External DC Supply (RL to Negative)

90 - 260Vac Supply

SULTAN Terminal Connection

L1
N

AC Supply

User DC Supply
+
−

+
PLC
DCS
IND
RL Max 400Ω
4-20mA

NOTE: RL Max = 750Ω if user DC Supply 24V

Use shielded cable

−
+
Is

4-20mA

Sultan output is sinking/controlling current. Voltage to drive current loop must be provided by PLC, indicator or external DC supply.
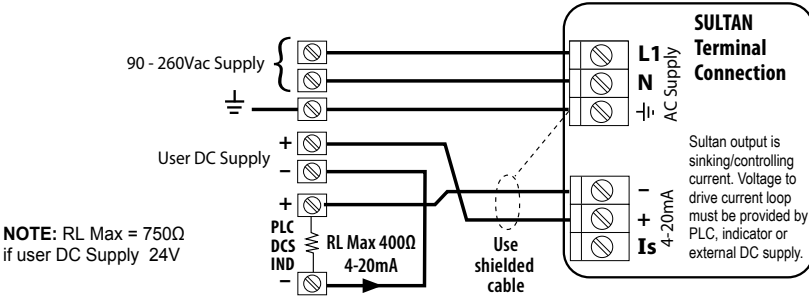
c) Modulating from User's External DC Supply (RL to Positive)

90 - 260Vac Supply

SULTAN Terminal Connection

L1
N

AC Supply

User DC Supply
+
−

+
PLC
DCS
IND
RL Max 400Ω
4-20mA

NOTE: RL Max = 750Ω if user DC Supply 24V

Use shielded cable

−
+
Is

4-20mA

Sultan output is sinking/controlling current. Voltage to drive current loop must be provided by PLC, indicator or external DC supply.
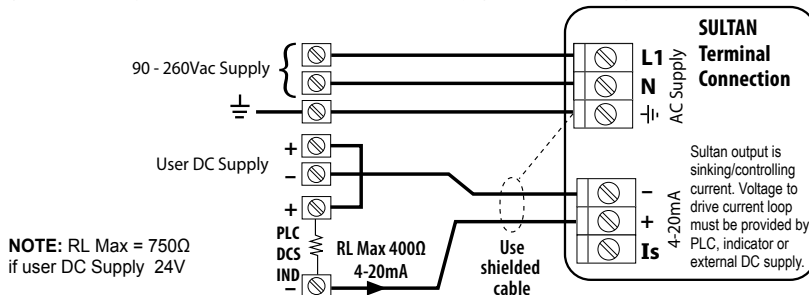
WIRING

4-20mA Output Connection
Terminal Connections for DC Powered Operation – AWST models and all 234 models with SIM card positioned for 3/4 wire mode.

d) 4 Wire DC– Driving from Internal Isolated Supply (Is)

NOTE:
Isolated current output can be made common with +DC or GND if required. (e.g. RL – connected to GND)

User DC Supply + −

PLC DCS IND

RL Max 270Ω

4-20mA

Use shielded cable

SULTAN Terminal Connection

+DC
GND
DC Supply

−
+
Is
4-20mA

Sultan output is sourcing current and provides voltage to drive a passive load, PLC input or indicator.
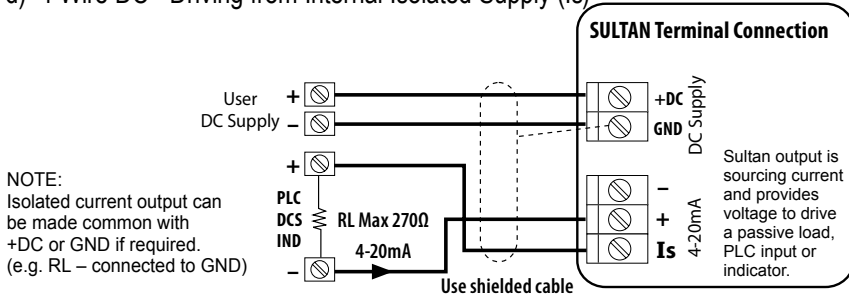
e) 3 Wire DC – Modulating from Common User Supply (RL to Negative)

NOTE:
RL Max = 750Ω if user DC Supply 24V

User DC Supply + −

PLC DCS IND

RL Max 400Ω

4-20mA

Use shielded cable

SULTAN Terminal Connection

+DC
GND
DC Supply

−
+
Is
4-20mA

Sultan output is sinking/controlling current. Voltage to drive current loop must be provided by PLC, indicator or external DC supply.
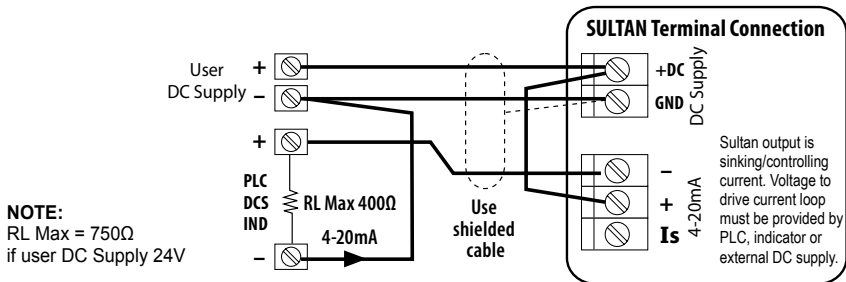
f) 3 Wire DC – Modulating from Common User Supply (RL to Positive.)

NOTE:
RL Max = 750Ω if user DC Supply 24V

User DC Supply + −

PLC DCS IND

RL Max 400Ω

4-20mA

Use shielded cable

SULTAN Terminal Connection

+DC
GND
DC Supply

−
+
Is
4-20mA

Sultan output is sinking/controlling current. Voltage to drive current loop must be provided by PLC, indicator or external DC supply.
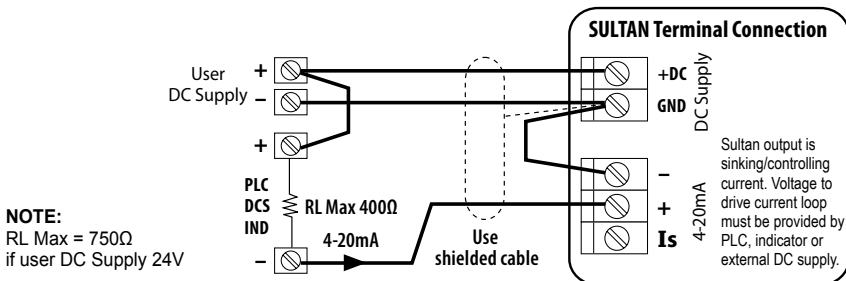
WIRING

4-20mA Output Connection

Terminal Connections for DC 2 Wire 4-20mA Loop Powered Operation
AWSTA, Sultan 2 and 234 models with SIM Card positioned for 2 wire mode.
g) 2 Wire DC Loop Powered

User DC Supply

NOTE:
Internal SMART
card configured
for 2 wire.

PLC
DCS
IND

RL Max 400Ω
4-20mA

Use
shielded
cable

**SULTAN
Terminal
Connection**

Sultan provides
4-20mA current
control of the
same 2 wires
which supply DC
power to operate
the unit.

− + Is   4-20mA
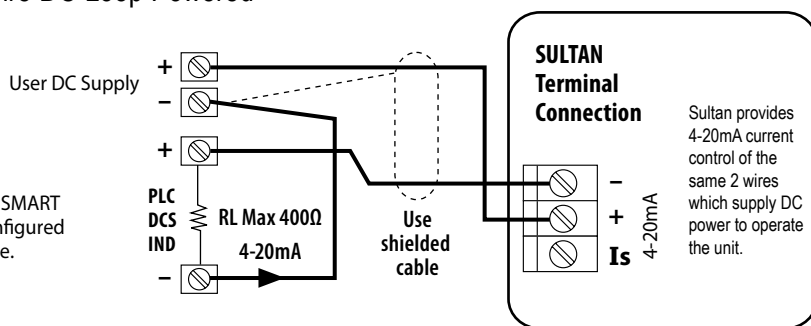
WIRING

RELAY FUNCTIONS
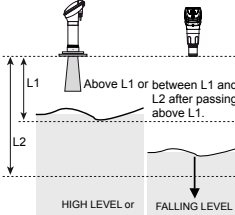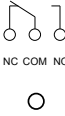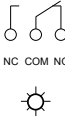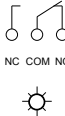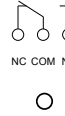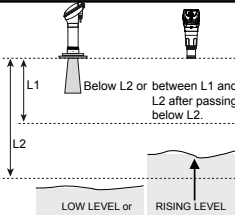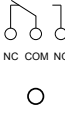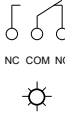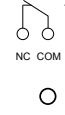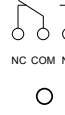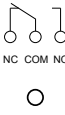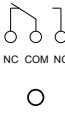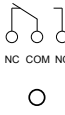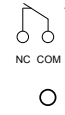
Level Switch Contact Action

Relay - for Smart AWSTC/D versions (Set Relay Parameters in Output Adjustment menu via GosHawk2 software)

Relay 1, 2 - for Integral 234 versions (Set Relay Parameters in Output Adjustment menu via local keypad or GosHawk2 software)

Relay 1-5 - for Remote 234 versions (Set Relay Parameters in Output Adjustment menu via local keypad or GosHawk2 software)

Notes:
1. Sultan 2 and AWSTA versions do not support relay outputs.

2. Sultan 234 versions operating in 2 wire loop powered mode do not support relay outputs.

3. L1 and L2 distances are measured from the transducer face or flange face.

4. L1 must be equal to, or less than L2.

WIRING

Cross Talk Prevention

The term Cross Talk is used to refer to interference between acoustic wave units of the same frequency located near to one another.

Sultan units emit high powered acoustic waves so only a small loss of signal will and occur through the environment where a sensor is working. As a result, transducers located near to one another, or in a common space are likely to 'hear' direct or reflected signals from one another.

Cross Talk may cause one or more of a group of sensors located near to one another to generate randomly false measurements and outputs whilst giving correct performance at other times.

Cross Talk is more likely to cause problems where the applications require units to be programmed to accept fast changes of level.

It is recommended that units working near to one another be linked according to the following steps to eliminate the possibility of Cross Talk.

1. All units to be linked must be connected to a common ground, or have wiring between their 'GND', or their 'DC-' terminals (parallel connection of all units).

* GND and DC- terminals are electrically connected inside Sultan 234 units, so either one may be used.
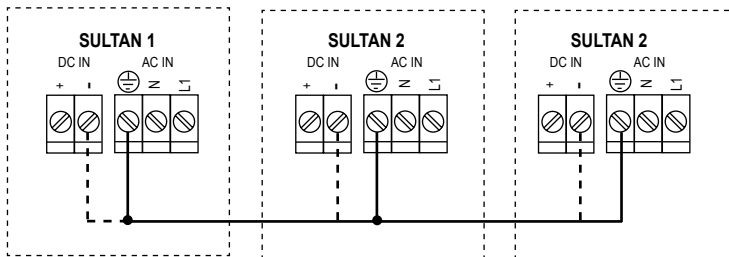
WIRING

Cross Talk Prevention

2. At each individual unit, wire a connection between Relay 1 'Common' terminal and the 'TEST' terminal of the same amplifier.

3. Wire a connection between the Relay 1 'Normally Open' terminals of all units to be linked (parallel connection of all units).
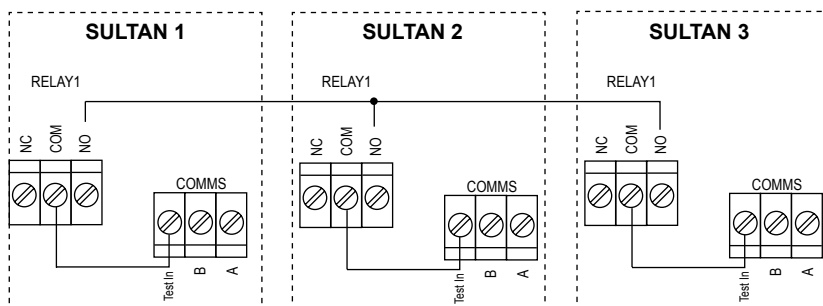
4. In the software setup of each individual unit, program Relay 1 to 'FS' (Fail-safe) mode in the Output Adjust menu. (You could use a different relay number in the same way if Relay 1 is needed for another function). The units will now be linked so that they can not crosstalk.

The 'TEST' terminal acts as an input when the unit is about to pulse, and will cause the instrument to enter a paused state (not pulse) if it sees a connection to ground. Each unit also drives its own 'TEST' terminal to ground when it is busy pulsing. These two functions combined mean that if two or more units have their 'TEST' terminals connected in parallel, and share a common ground, then at any time when one is pulsing, it will ground the 'TEST' terminals of all units to which it is connected, and temporarily pause them until it is finished, then release them. The next unit which becomes ready to pulse will follow the same procedure in turn, and the process continous in an endless cycle.

The connections described are made vis a normally open rely contact, programmed into Failsafe mode. The function of this is simply to prevent a possible lock up of the whole system if one unit has a problem e.g. power failure. If at any stage a transducer is in its failed state, it will be disconnected by the relay from the other units, so they can continue to work together.

WIRING

MULTIDROP CONNECTIONS

Multidrop GSM/GPRS/CDMA Connection*

HawkLink
GSM/GPRS/CDMA unit

A B Gnd   A B Gnd   A B Gnd

A B Gnd

Laptop or PC Communications using
PCMCIA card or wired (PSTN) modem
or Internet and remote GSM/GPRS/CDMA
connection with GosHawk software.
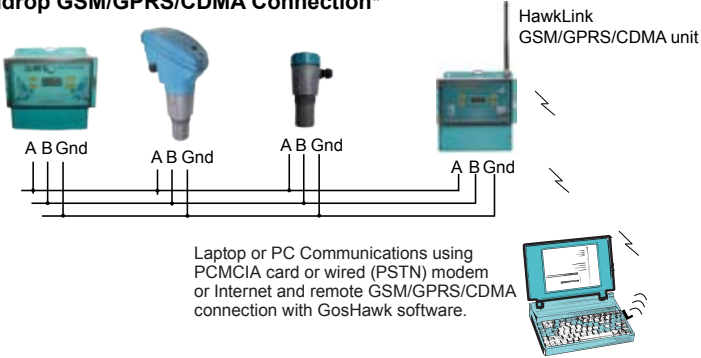
Multidrop Connection Using HawkLink USB*

A B Gnd   A B Gnd   A B Gnd

Hawklink
USB

Laptop or PC Communications using
Hawklink USB or RS485 / 232 converter
with GosHawk software.

A B Gnd
White
Blue
Black
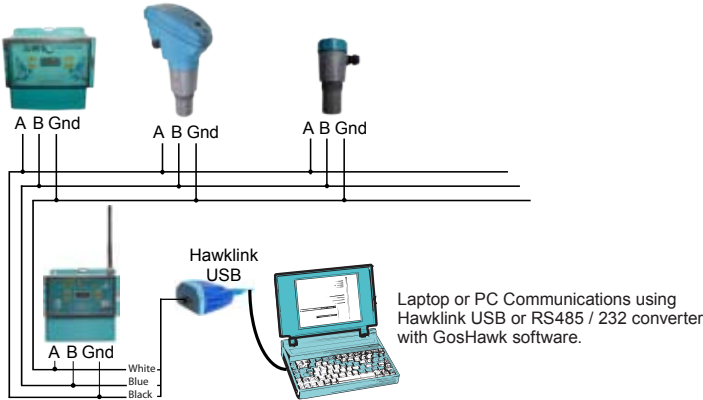
Multidrop Connection to PLC/DCS/SCADA*

A B Gnd   A B Gnd   A B Gnd

PLC / DCS / SCADA for Remote
Communication with Modbus.
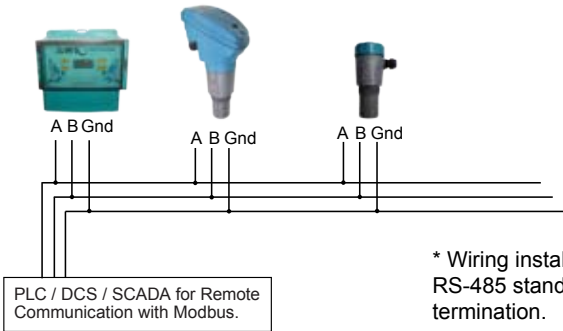
* Wiring installation should follow
RS-485 standards for layout and
termination.

2 WIRE UNIT COMMUNICATIONS

The Sultan 2 wire units are 2 wire loop powered only. This means that they can not work when multi-drop connected on Modbus networks. In order to multi-drop connect units, they must not be 4-20mA (2 wire loop) powered. Gladiator, Orca, Sultan 234 or Smart AWSTC or AWSTD types are necessary for networked installations. When using an instrument powered by 2 wire connection, all current must enter and leave an instrument via the pair of loop wires, and fixed connection of other terminals in parallel to other units, or to a ground or common point may interfere with the operation of the unit, the current output, or any communications.

The communications terminals on 2 wire units are not designed for permanent connection and networked use. Communication is possible with these units, but only on a one to one basis, and only without reference to any ground. Communications on these products are provided to allow setup, commissioning and diagnosis, and during actual communication, there may be some noise generated on the current loop. It is normally best to use a laptop running on battery power only, connect only the A and B terminals, without the ground/shield, in order to minimize any noise or interference with the current loop.

WIRING

HAWKLINK GSM - CONNECTING POWER AND COMMS
USING DC POWER DERIVED FROM AC POWERED REMOTE OR INTEGRAL SULTAN 234

Existing AC power supply (GSM will be powered by DC generated by the Sultan)

Connect shield to DC "–" only at this end.
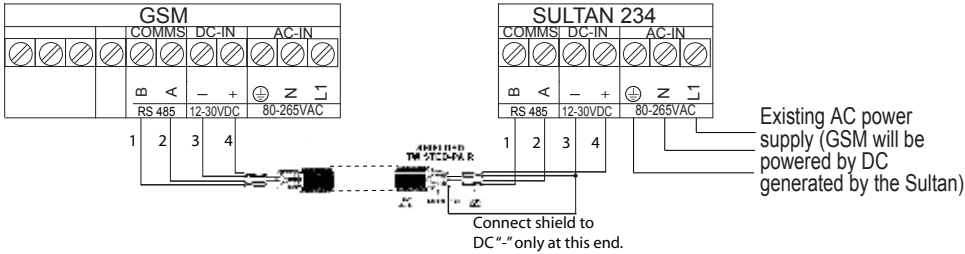
USING DC POWER FROM REMOTE OR INTEGRAL SULTAN 234
OR AWSTC/AWSTD
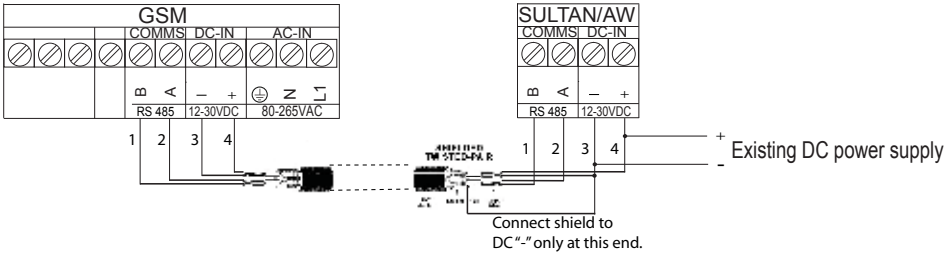
Existing DC power supply

Connect shield to DC "–" only at this end.

⚠ TERMINAL ORDER VARIES BETWEEN SULTAN INTEGRAL, REMOTE, AN SMART TYPES. ENSURE CORRECT LAYOUT IS USED - SEE TERMINAL LAYOUTS PAGE xxx.

WIRING

HAWKLINK GSM - CONNECTING POWER AND COMMS
USING SEPARATE AC OR DC POWER WITH REMOTE OR INTEGRAL SULTAN 234 OR AWSTC/AWSTD
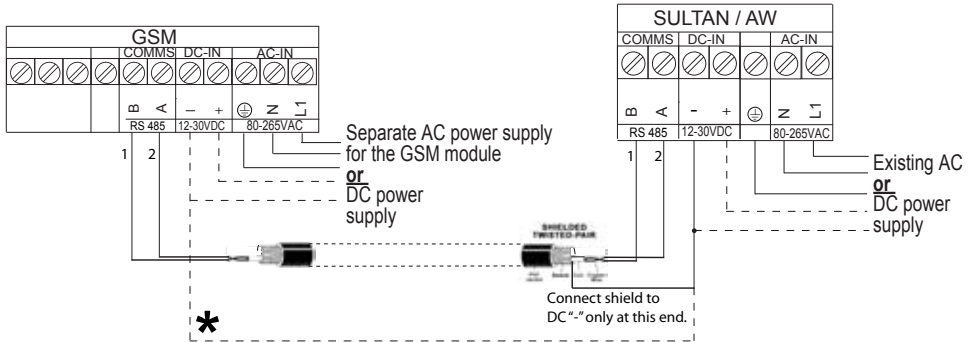
* Ensure separate DC supplies have the same ground potential

USING SEPARATE AC OR ISOLATED DC POWER WITH SULTAN 2, SULTAN 234 IN TWO WIRE MODE, OR AWSTA
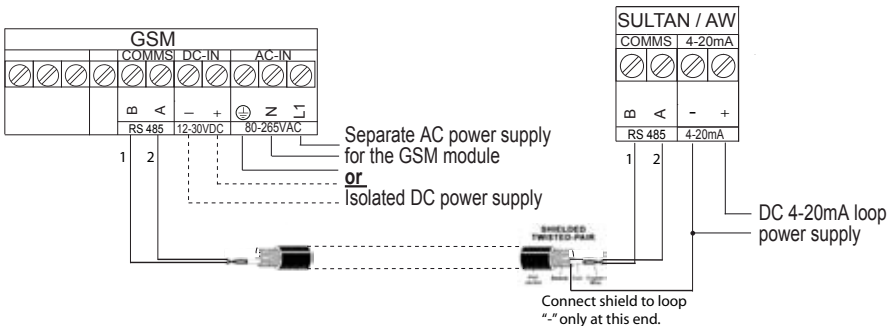
! TERMINAL ORDER VARIES BETWEEN SULTAN INTEGRAL, REMOTE, AN SMART TYPES. ENSURE CORRECT LAYOUT IS USED - SEE TERMINAL LAYOUTS PAGE xxx.

WIRING

TEST TERMINAL - SULTAN 234 AND AWSTC/AWSTD ONLY

PAUSED MODE

The TEST terminal of an Sultan series product can be used as an input to the instrument, which cause it to pause in its operation. During paused mode the unit will stop making measurement pulses, and the output will hold in its current position (after any remaining damping to the current position has finished). Internal echo tracking functions such as window opening and hold time counting will continue to operate, so that when the paused state is released, the instrument will be immediately ready to resume measurement allowing for possible target movement during the paused time.

The test input can be used to silence a Sultan system when it is not required to measure, and is also used in the prevention of Cross Talk, see page XXX.

To place a Sultan unit into paused mode using the test input, a connection must be made between the power supply ground or DC- and the TEST terminal.

During paused mode, the word 'Paused' will be seen on the top line of the display if viewing the operating mode diagnostic.

PAUSE FROM PLC/SCADA/DCS DIGITAL OUTPUT

Terminal Block

PLC / SCADA / DCS Output

Test

(!) PLC/SCADA/DCS GROUND MUST CONNECT BACK TO SULTAN GROUND OR DC '-' TERMINALS
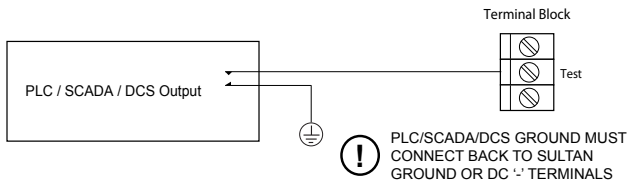
OPERATOR CONTROLLED PAUSE

Terminal Block

Externally provided test switch

Test

(!) EXTERNAL SWITCH GROUND MUST CONNECT BACK TO SULTAN GROUND OR DC '-' TERMINALS
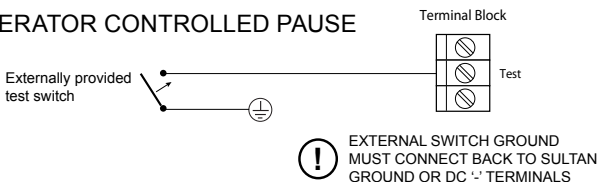
WIRING

LIGHTNING PROTECTION

Surge Protection Device

Specifications

- Description: Surge protector for 4/20mAprocess instruments.

- Protection modes: Transverse & common mode

- Protection stages: Gas arrester/transorb

  Surge rating: 20kA for 8/20µ s pulse

- Transverse mode clamp: Voltage 36V peak

- Arrester firing voltage: 230V peak

- Arrester residual voltage: 20V peak

- Material: Nickel plated brass, epoxy filled

- Standards compliance:
  IEEE C62.41 cat, A, B, C
  AS1768-2003 cat. A, B, C

- Approval:
  AUS Ex2428U
  Ex d IIC T4 Class 1 Zone 1
  Ex ia IIC T4 Class 1 Zone 1

Connection

3 wires :- 1 to ground; 2 active (1 to each loop connection). All need to be kept as short as possible.

Remote Sultan

The enclosure can accommodate the device mounted in one of the M20 cable gland positions.
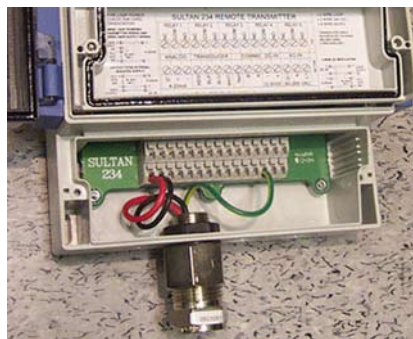
Integral Sultan

No M20 adaptor required
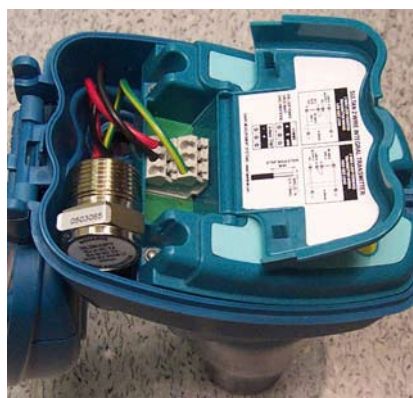
WIRING

CHANGE SULTAN 234 <=> SULTAN 2

It is necessary to have SULTAN 234 version to change to and from SULTAN 234 to SULTAN 2 wire connection. Wiring must be changed according to the wiring diagrams.

Note: On the module there is a removable card. The card needs to be **carefully** removed with the power off. The card

is then turned over to show 2 wire (for 2 wire operation) or 234 wire (for 234 wire operation). Insert the card with the required wiring connection facing the sticker SMART card connection. Wire the unit as required, apply power.

INTEGRAL SULTAN 234
 To change SMART CARD from 3,4 wire to 2 wire.

Lift cover

Remove screws

After screws are removed, lift facia to expose the potted modules.
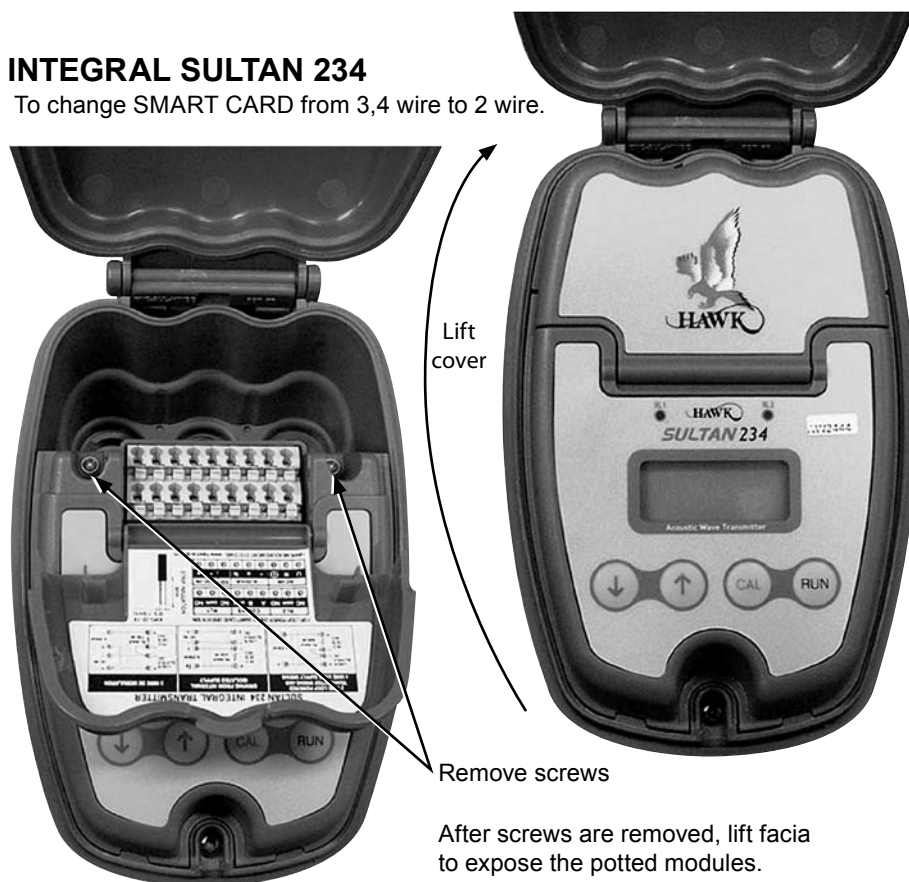
WIRING

CHANGE SULTAN 234 <=> SULTAN 2
Changing 2 wire to 3, 4 wire or 3,4 wire to 2 wire

Sim SMART CARD
Reverse/Remove
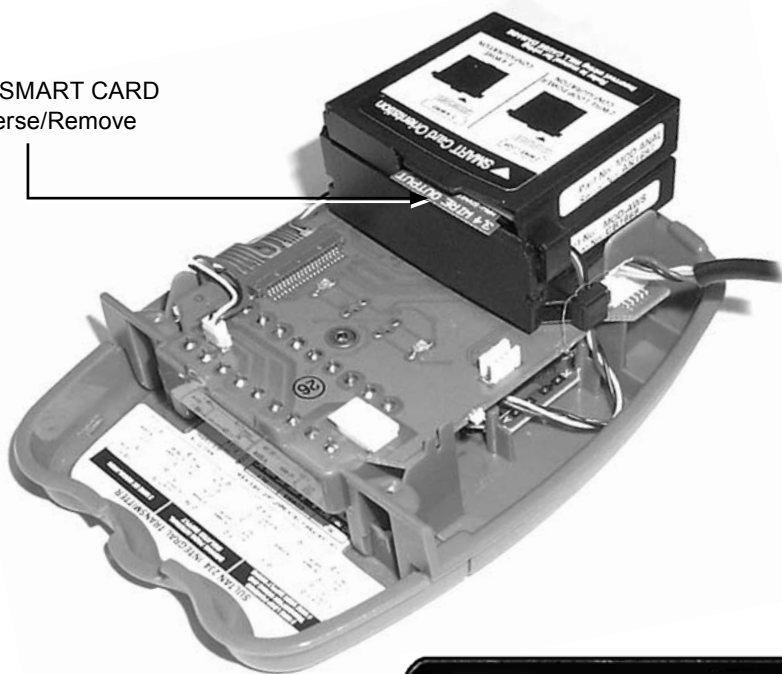
For correct sim SMART CARD
orientation, ensure the type of
connection faces the sim card
orientation sticker.

▼ SMART Card Orientation

2 WIRE LOOP   3, 4 WIRE

2 WIRE LOOP POWER
CONFIGURATION

3, 4 WIRE
CONFIGURATION

**Refer to manual for wiring
Incorrect wiring WILL CAUSE DAMAGE**
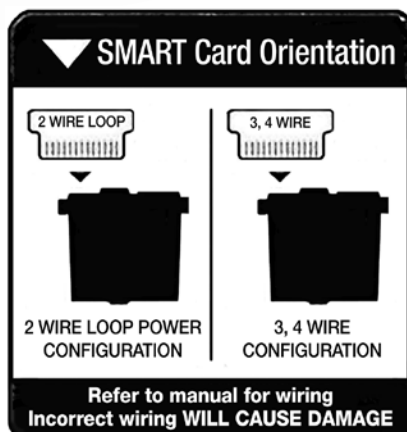
WIRING

CHANGE SULTAN 234 <=> SULTAN 2
Remote Sultan 234 > to change SMART CARD from 3, 4 wire to 2 wire
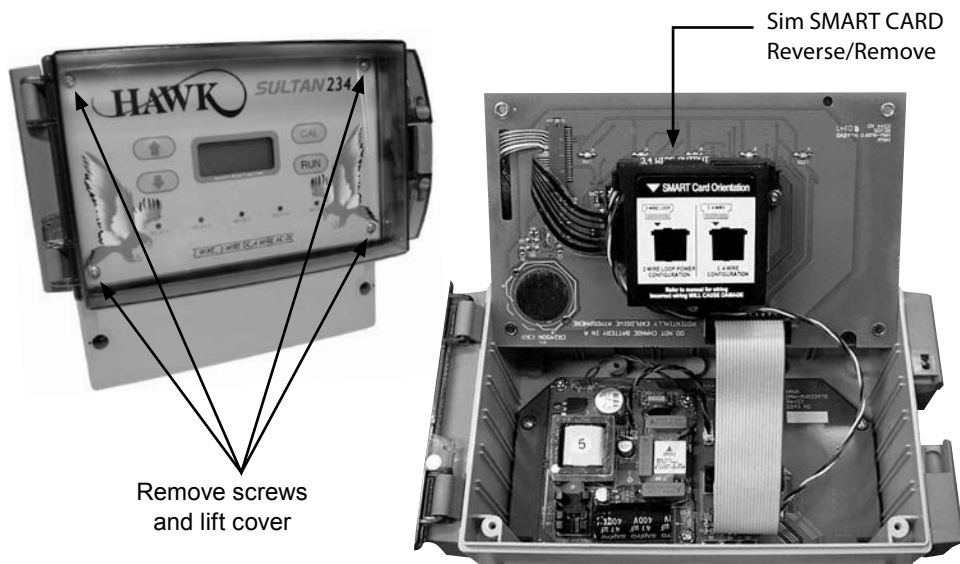
Sim SMART CARD
Reverse/Remove

Remove screws
and lift cover

For correct sim SMART CARD
orientation, ensure the type of
connection faces the sim card
orientation sticker.
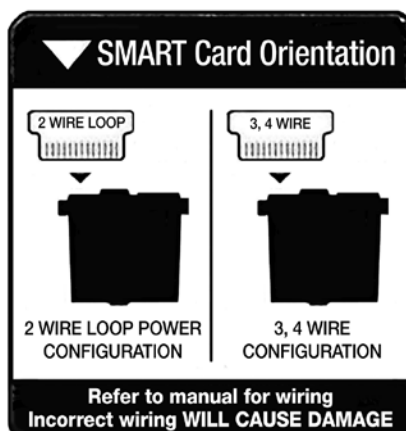
For connection to GosHawk II, see
separate manual available on:

www.hawkmeasure.com

▼ SMART Card Orientation

2 WIRE LOOP	3, 4 WIRE
2 WIRE LOOP POWER CONFIGURATION	3, 4 WIRE CONFIGURATION

**Refer to manual for wiring
Incorrect wiring WILL CAUSE DAMAGE**

WIRING DIAGRAMS

Integral - Profibus / DeviceNet

Profibus

234 INTEGRAL TRANSMITTER

2 WIRE LOOP POWERED TRANSMITTER WIRING AND 4 WIRE USER SUPPLY WIRING	DRIVING FROM INTERNAL ISOLATED SUPPLY	3 WIRE DC MODULATION

USER SUPPLY DC

PLC DCS IND

RL MAX 500 Ω

4-20mA

PLC DCS IND

RL MAX 400 Ω

Is

4-20mA

USER SUPPLY DC

DC IN

USER SUPPLY DC

DC-IN

PLC DCS IND

RL MAX 750 Ω

4-20mA

FOR LOOP POWER CHECK SMART CARD ORIENTATION

PBDP in			COMMS			RL1		
Ain	Bin	shld	A	B	shld	NC	com	NO

AC-IN			PBDP out			TEST	DC-IN	
LI	N	⏚	Aout	Bout	shld		-	+

AWG 22 -14
(0.5 -1.5mm)

STRIP INSULATION
9mm

- Minimum Voltage - 24vdc 0R ac TO Our unit
- Nominal Current - 400mA
- Connector Type - Terminal see wiring info

DeviceNet

234 INTEGRAL TRANSMITTER

2 WIRE LOOP POWERED TRANSMITTER WIRING AND 4 WIRE USER SUPPLY WIRING	DRIVING FROM INTERNAL ISOLATED SUPPLY	3 WIRE DC MODULATION

USER SUPPLY DC

PLC DCS IND

RL MAX 500 Ω

4-20mA

PLC DCS IND

RL MAX 400 Ω

Is

4-20mA

USER SUPPLY DC

DC IN

USER SUPPLY DC

DC-IN

PLC DCS IND

RL MAX 750 Ω

4-20mA

FOR LOOP POWER CHECK SMART CARD ORIENTATION

DEVNET			COMMS			RL1		
A	B	shld	A	B	shld	NC	com	NO

AC-IN			DEVNET			TEST	DC-IN	
LI	N	⏚	shld	GND	24V+		-	+

STRIP INSULATION
9mm

AWG 22 -14
(0.5 -1.5mm)

WIRING DEVICENET

5. V+
4. CAN_H
3. SHEILD
2. CAN_L
1. V-

DEVICENET

Set the BaudRate and the DeviceNet Address in Sultan

Factory defaults of baudrate and FBusAdds are 125kbps and 63 in a Sultan unit with DeviceNet CommType. To modify these values follow the instructions below.

1. Go to the Output Adjustment menu

2. Use the Up and Down push buttons to reach the CommType parameter

3. Make sure that the CommTyle is set to DeviceNet

4. Press the CAL button twice

5. DeviceID will be displayed

6. Use the Down push button to reach the BaudRate parameter

7. The default value for the BaudRate is 125kpbs. Press CAL button and use the Up and Down push buttons to modify this value

8. Press CAL button when finished

9. Use the Down push button to reach the FBusAdds. The default value of the FieldBus Address is 63. Press CAL button and use the Up and Down push buttons to modify this value

10. Press CAL button again when finished

Output Data

Profibus/Devicenet now transmit 18 bytes/9 words, description of the words is as follows (For firmware version 5.54 and above)

1. Displayed Distance (Space Distance is the Primary Variable)
2. Percentage (Percent of Range)
3. Hi Level (Upper Range)
4. Low Level (Lower Range)
5. Status Flags

Failed	~~~~~	Search	0	Echo Cfm : 1 = True, 0 = False	Echo R : 1 = True, 0 = False
Bit F	Bit E	Bit 3		Bit 1	Bit 0

Bit0 = Echo was received inside the span.
Bit1 = Echo is Confirmed.
Bit3 = Searching is searching for an Echo.
BitF = Unit has Failed to detect an Echo.

6. Displayed Distance2 (Second Variable)*
7. Percentage2 (Second Percent of Range)*
8. Displayed Distance3 (Third Variable)+
9. Percentage3 (Third Percent of Range)+

* Used for ORCA Sonar and Differential output on a Sultan
+Only used for ORCA Sonar Clarity output.

PROFIBUS

5. B IN
4. A IN
3. SHEILD
2. B OUT
1. A OUT
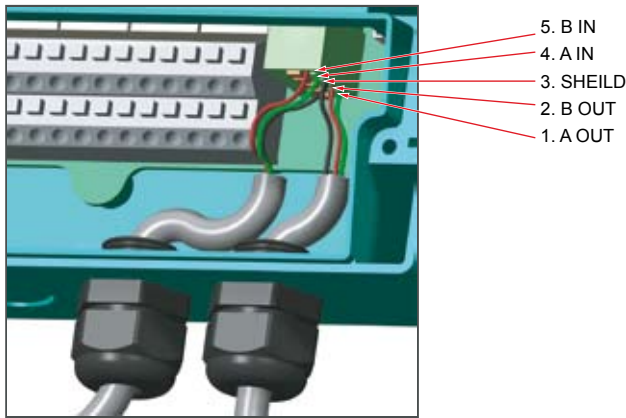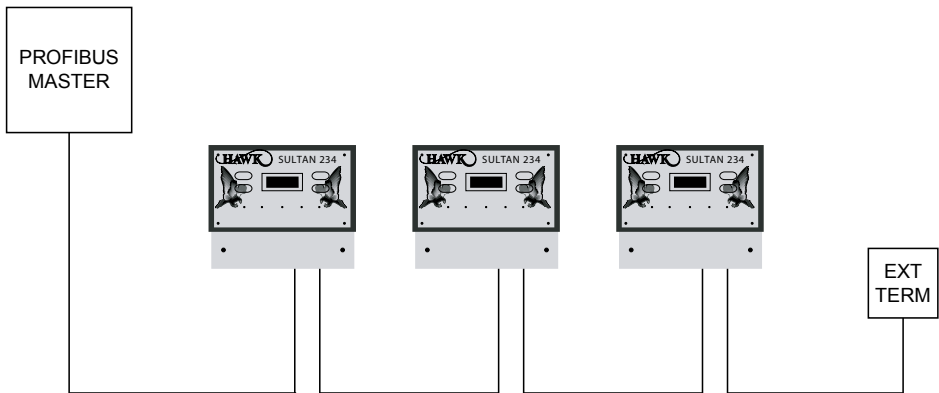
PROFIBUS

Set the ProfiBus Address in Sultan

Factory defaults of FBusAdds is 126 in a Sultan unit with ProfiBus CommType. To modify this value follow the instruction below:

1. Go to the output Adjustment menu.

2. Use the Up and Down push buttons to reach the CommType parameter.

3. Make sure that the CommType is set to ProfiBus

4. Press the CAL button twice.

5. DeviceID will be displayed

6. Use the Down push button to reach the BaudRate parameter.

7. The value for the BaudRate is selected automatically and can not be modified.

8. Use the Down push button to reach the FBusAdds. The default value of the FieldBus Address is 126. Press CAL button and use the Up and Down push buttons to modify this value.

9. Press CAL button again when finish.

Output Data

Profibus/Devicenet now transmit 18 bytes/9 words, description of the words is as follows (For firmware version 5.54 and above)

1. Displayed Distance (Space Distance is the Primary Variable)
2. Percentage (Percent of Range)
3. Hi Level (Upper Range)
4. Low Level (Lower Range)
5. Status Flags

Failed	~~~~~~	Search	0	Echo Cfm : 1 = True, 0 = False	Echo R : 1 = True, 0 = False
Bit F	Bit E	Bit 3		Bit 1	Bit 0

Bit0 = Echo was received inside the span.
Bit1 = Echo is Confirmed.
Bit3 = Searching is searching for an Echo.
BitF = Unit has Failed to detect an Echo.

6. Displayed Distance2 (Second Variable)*
7. Percentage2 (Second Percent of Range)*
8. Displayed Distance3 (Third Variable)+
9. Percentage3 (Third Percent of Range)+

* Used for ORCA Sonar and Differential output on a Sultan
+Only used for ORCA Sonar Clarity output.

COMMUNICATION - MULTIDROP CONNECTION

Gladiator Admittance Switch

Gladiator Admittance Switch

Gladiator Admittance Switch

Gladiator Admittance Switch

Sultan Acoustic Wave Transmitter
Slurries

Sultan Acoustic Wave Transmitter
Floatation Cells

GLadiator Microwave Low Level

Gladiator Microwave Low Level

Gladiator Vibration Switch

Sultan Acoustic Wave Transmitter
Silo, bin levels, coal, plastic powder, woodchip, sawdust, cement, clinker, iron ore, lime etc.

Gladiator Conductivity Switch

Orca Sonar Interface
Thickener, CCD

Gladiator Conductivity Switch

Sultan Smart Transducer
Farm Tanks, Grain Terminals

Sultan Acoustic Wave Switch
Blocked Chute Detection

Orca Sonar Interface
Clarifier

GSM Network
or
CDMA Network

Sultan Master/Slave Positioning System

Sultan Acoustic Wave Transmitter
Stockpiles, Stackers, Reclaimers

GSM or CDMA Network

- Typically up to 31 transmitters or switches per string.
- Maximum 250 transmitters or switches.
- Using GSM/CDMA network, transmitters and switches can be monitored, calibrated remotely.
- Alarm status, diagnostics can be monitored.
- Support from factory engineering for customer application problems.

Laptop or PC Communications or PLC / DCS with MODBUS RTU Port GosHawk Software for inventory monitoring on PC

(Limited Modbus query rate for Switches only)

COMMUNICATION - REMOTE

GSM/CDMA Communication

HawkLink GSM/CDMA communication device allows any authorized computer with a standard modem and GosHawk software to dial in and calibrate, test or check on the performance of the connected Hawk product. The HawkLink device can be wired to the standard communication terminals of the Hawk products.

Remote technical support and complete commissioning of equipment in applications via our GSM/CDMA module allows monitoring and adjustments of settings no matter what corner of the world.

Protocols

GosHawk
HART
Modbus
Profibus DP
Profibus PA
Foundation Fieldbus
DeviceNet

Remote connection worldwide!
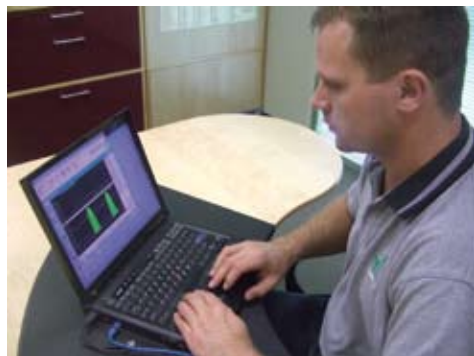
AVERAGE LEVEL

What is Average Level?

Average mode is used to measure the average of two material levels using two sensors and one amplifier, and provides one output result.

In average mode, two individual sensors are referred to as Sensor 1 and Sensor 2. Capability for averaging of more than two sensors may be added in the future.

Average Material Calculation

The display mode 'AvgMatrl' (Average Material) gives a result calculated as follows:

AvgMatrl = LowLevel – AvgSpace
where
AvgSpace = (Space1 + Space2 + offset)/2

Analog Output

Analog output is calculated based on the average material level.

The span of the analog output is defined by the LowLevel and HiLevel parameters. The analog output is calculated as follows:
Current (mA) = 16* AvgMatrl/ (LowLevel-HiLevel) + 4mA

Relays

The relays are switched based on the average space value. The relay set points L1 and L2 should be set considering the average space values at which the relay is required to switch.
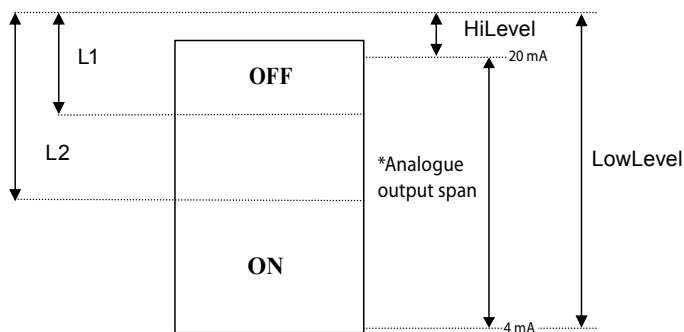
Relay Mode = EN

* 4-20 mA action may be reversed according to setting of the 'Analog' parameter in the Output Adjustment menu.

AVERAGE LEVEL

Relay Mode = DEN
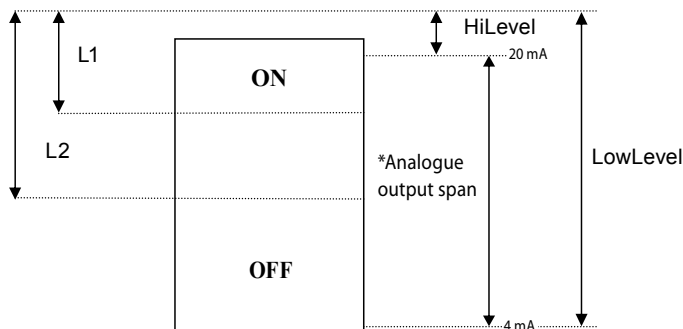
* 4-20 mA action may be reversed according to setting of the 'Analog' parameter in the Output Adjustment menu.

To use Average mode, two sensors must be assigned different addresses.

Carefully follow the steps below starting with 2 new sensors:

1. Connect only the sensor which will be used as Sensor 2 to the amplifier.
2. In 'Quickset' set the 'DispMode' to 'AvgMatrl'.
3. Set the 'Sensors' parameter to a value of 2.
4. Set the '1:SenAdd' parameter to a value of 1.
5. Set the '1:TxAdd' parameter to a value of 1.
6. Set the '2:SenAdd' parameter to a value of 1.
7. Set the '2:TxAdd' parameter to a value of 2.
8. Connect Sensor 1 together with Sensor 2.

The system is now ready for measurement, and in the 'Run' mode both sensors should pulse alternately.

Accessing both Sensors Parameters

Both sensor1 and sensor 2 parameters can be accessed through KeyPad and GosHawkII.

Via KeyPad
The parameter 'Sensor' in the TxSetup, Tracking and Factory menus determines which sensor (1 or 2) will be currently accessed via that menu.

Via GosHawkII
When on Run mode, press the down key once to get the 'Tx' value on the display. If 'Tx' is 1, then GosHawkII will communicate with Sensor 1 and the diagnostics displayed will refer to Sensor 1. To swap to the other sensor, hold both the 'Up' and 'Down' arrow buttons simultaneously.

AVERAGE LEVEL
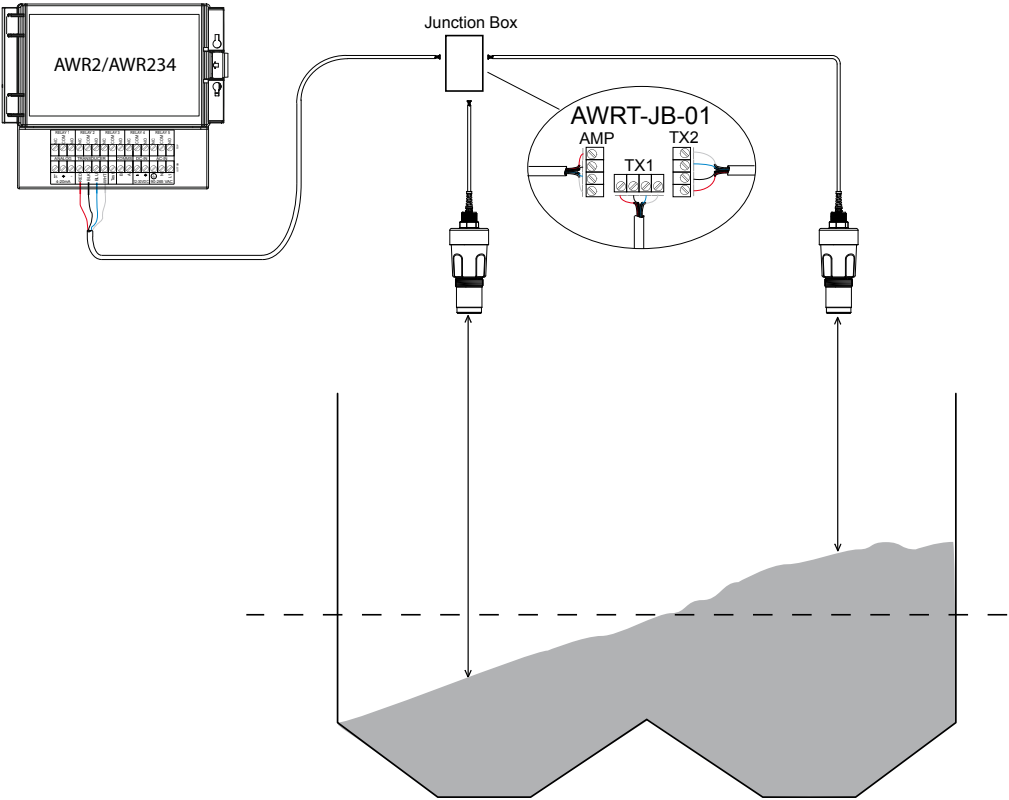
DIFFERENTIAL LEVEL

What is Differential Level?

Differential Level is the term used to define the measured difference between two material levels. Measurement of Differential Level is achieved by using two sensors and one amplifier. Below is reference as to how the two sensors need to be setup and connected to the amplifier.

Sensor Addressing
Parameters *1: SenAdd* and *2: SenAdd*: in Quickset menu are the MODBUS addresses of sensor 1 and sensor 2 saved in the unit. The default MODBUS addresses of sensor 1 and sensor 2 are 1 and 2.

Important notes:
• Changing SenAdd, does not change the transducer modbus address.
• To change the transducer address, change the TxAdd.
• To get to TxAdd parameter press CAL twice when on SenAdd.

Both sensors which are connected to the amplifier must have different MODBUS addresses then the following needs to be carried out:

1. Set the application type to Diff on the Sultan unit;
2. Connect the sensor that is used as sensor No2.
3. Set 2:SenAdd to 1 and press Cal twice.
4. Set the 2:TxAdd to 2.
5. Connect Sensor No1.

DIFFERENTIAL LEVEL

Analog Output

Analog output is calculated based on the differential value.
The span of the analog output is according to the Lowlevel1 and Hilevel1. The analog output is calculated according the following equation:

Current (mA) = 16 * (Diff)/(LowLevel1 − HiLevel1) + 4mA

Relays

The relays are switched based on the diff value. This means that the relay set points L1 and L2 should be set to diff values that the relay is required to switch.

Relay Mode = EN (L1 < L2)	Relay Mode = DEN (L1 < L2)

OFF	ON
L2 = Diff2 _____	L2 = Diff2 _____
L1 = Diff1 ————————————	L1 = Diff1 ————————————
ON	OFF

Differential Mode

Differential Mode is introduced to measure the difference between two material levels using two sensors and one amplifier.
Each sensor has its own Hi and Low levels. Parameters, LowLevel2 and HiLevel2 were introduced for sensor 2. This is useful when the sensors are not mounted at the same levels.

Diff Calculation

In differential Mode the material level measured by sensor 1 is subtracted from the material level measured by sensor 2. Negative results will be reset to zero. The differential value is calculated as follow:

Diff = MaterialLevel2 − MaterialLevel1
MaterialLevel2 = LowLevel2 − Space2
MaterialLevel1 = Lowlevel1 − Space1

DIFFERENTIAL LEVEL WIRING
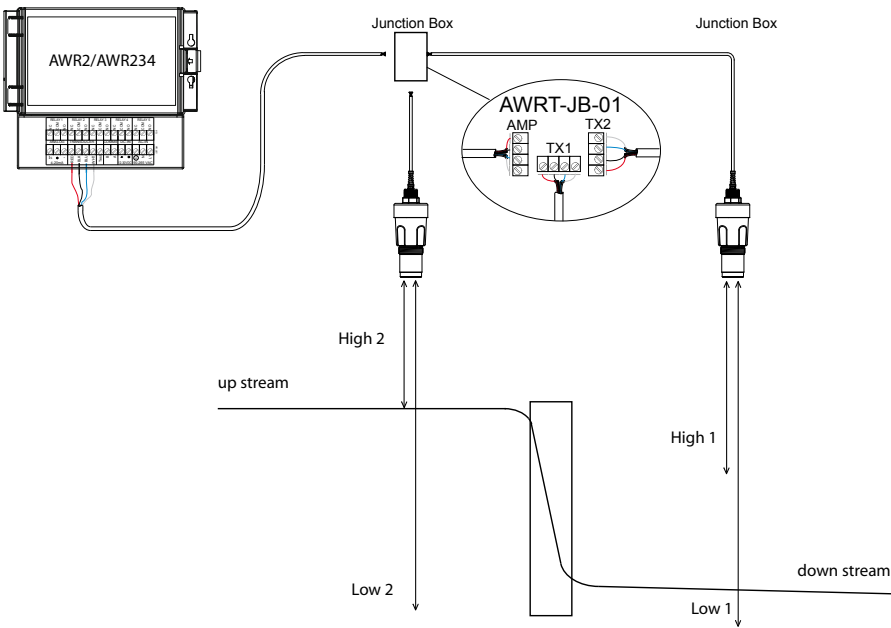
OPEN CHANNEL FLOW MEASUREMENT PRINCIPLES

OBSTRUCTIONS IN CHANNEL CAUSE RISE IN LEVEL

An obstruction in a channel represents a reduction of the cross-section of the channel. Since practical liquids are essentially incompressible, the volume of liquid flowing past an obstruction must equal the volume flowing towards it. It follows that the liquid must divert around the obstruction.If a barrier to flow is installed across the bottom of a channel, the liquid level rises as it flows over it - this leads to the use of the weir in open-channel flow measurement. If the cross-sectional area of a channel is reduced, the liquid level must rise as it flows past - this leads to the flume.
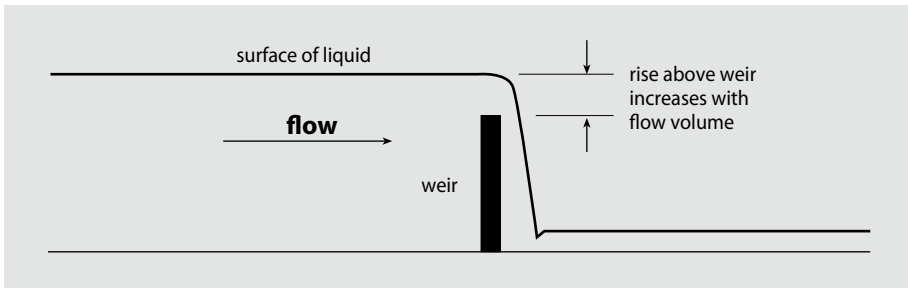
The height of the liquid surface above the Weir is called the Flow Head **(h)**. The head is known to be related to the Volume Flowrate **(q)**, allowing the flowrate to be calculated from measurement of the head.

The formula is of me form:

$$q = kh^a$$

where the exponent a is typically about 1.5 and the constant k depends upon the channel and weir dimensions. Different shapes of weir have been developed to provide improved accuracy under different conditions, but the principle is the same for all. These various weirs have different exponents, but most within the range of 1.3 to 1.7.

Flumes, in which the channel width is narrowed have become preferred for accuracy and robustness (eg. self scrubbing). Many flume profiles have been developed, each having its advantages and disadvantages for a given application. A similar exponential relationship exists between head and flowrate in these flumes, and each type has a different exponent, commonly in the range of 1.3 to 1.8.

SULTAN FOR POSITION MEASUREMENT

The Sultan series includes a product range specifically designed for machine position sensing. Such a system is typically used to provide a signal representing the linear position of a moving machine to a control system.

Sultan's high powered Acoustic Wave measurement technology applied in this way provides a reliable, simple solution to measuring machine positions in simple or difficult environments, and is able to provide secure performance in the presence of dust, steam and with complex mechanical structures nearby.

The system is a two part (Master-Slave) system, where each part is dimensionally similar to a standard Sultan Integral or Remote level measurement system.

The master system is in fact a standard Sultan level system, with its software set for position measurement. The slave system must be ordered specifically as it uses different components to the standard Sultan system.

-Each part: Master and Slave must be selected to have the same operating frequency as one another, as they work together to generate the position measurement.

-One part is located at a fixed point, facing the moving machine, in line with its axis of movement, and slightly beyond one end of its travel. The second part is located on the moving machine, facing the fixed unit in a direct line of sight.

-All control system connections are made ONLY to the Master unit. No control connections are required, nor available at the slave end.

-The customer may choose which part (Master or Slave) is located on the moving machine, according to the location and availability of control system inputs.

*Generally it is likely that placement of the Master unit at a fixed location, and the Slave on the moving machine will provide the simplest and least costly installation, as control system cabling then only needs to connect to a fixed point, not via any moving cable system to the moving machine.

-The customer may also choose to use Integral or Remote systems for either the Master or Slave parts.

*It is likely that the most convenient installation style will include a Remote unit for the Master, and an Integral for the Slave, as there is rarely any need to access or adjust the Slave, and an Integral unit is more compact and has a lower purchase cost. At the Master end, however, a Remote unit allows a convenient local display of the measured position, and provides a neat solution for connection of control wiring, and easy adjustment of operating parameters at a user accessible location, rather than directly at the sensor position.

-The Slave unit requires only power supply connections, and the Master requires power supply and control system signal connections.

Software Setup for Positioning Applications:
The basic setup of a system is done almost entirely from the Master unit. There is rarely any requirement to adjust the slave at all.

Adjustment of all parameters in the Master of a positioning system is almost identical to what it would be for a level application. The Sultan operation manual description of parameter setup for level applies equally for positioning, with the following simple differences:

Quick Set:
-Low Level and High Level span points in the instrument represent maximum and minimum amounts of product in a level application. In

SULTAN FOR POSITION MEASUREMENT

a position application, these settings refer to maximum and minimum positions of the moving machine, so the High Level refers to the minimum separation between the sensor or flange faces of the Master and Slave units, and the Low Level represents the maximum separation between the two sensor faces.

*Units should be mounted in such a way that at least the minimum 'Blanking Distance' as given on the specifications of the frequency of unit being used is maintained between the Master and Slave sensor faces at all times and all possible travel distances. It is recommended that where possible, double the specified distance should be used to provide some security margin in operation.

-All distances for setup parameters, and displayed distances in the 'Space' mode have a zero reference at the face or flange of the Master sensor.

-Select only 'Position' for the 'Application Type' parameter of the Sultan Software to provide optimal performance when used for a positioning application.

-Normally, select 'Space' for the 'Display Mode' parameter of the Sultan Software. The display will then show the separation distance between the two sensor faces.

-Set the 'Fill Rate' and 'Empty Rate' (found under 'Application Type') according to the maximum possible speeds of movement of the machine: Fill Rate to the maximum speed (in metres per hour) which the machine may move toward the fixed sensor, and Empty Rate to the maximum speed (in metres per hour) which the machine may move away from the fixed sensor.

Transducer Setup:
-Set the 'Gain' as required by the application to achieve a reliable signal (0.8-2.5V).
*The setting of 'Gain' required for a positioning

application should generally be significantly lower than that which would be needed for a level application over a similar distance. Positioning signals are direct from Master to Slave, or Slave to Master, and do not suffer the losses in reflection, or absorption in a round trip that would occur in a level application. If gain is set higher than needed, then echo signals from nearby structures can generate reflections and give false outputs.

-Check that the 'Gain Step' is set to a slightly lower value than the value selected above for 'Gain' (0.5% suggested minimum difference).

-Set the 'Blanking Distance' parameter to the minimum separation distance possible between the two sensors, with the moving machine at its minimum extreme of physical travel. As mentioned above, this must be greater than the 'Blanking Distance' given in the specifications.

-Set the 'Empty Distance' to slightly longer than the maximum separation distance possible between the two sensors, with the moving machine at its maximum extreme of physical travel.

*Sensors used in positioning systems can normally be used over much longer distances (typically double) than the same sensors used in a level application due to the lower losses with direct transmission and reception of signals compared to reflecting of a target.

Advanced Note:
*The 'Slope Distance' used for positioning systems is typically 2 times that used for level applications.

*Gain Values for Gain Steps and Gain parameter are generally significantly lower than the same frequency of instrument would use in a level application.

GAIN ADJUSTMENT

GAIN ADJUSTMENT (Gn)

Adjusting the Gn value will effect sensitivity of the acoustic wave system over the entire span except for that controlled by Gain Steps. The Gain Slope is not affected.

Note: The higher the Gain Value the more sensitive the system becomes.
SLOPE ADJUSTMENT
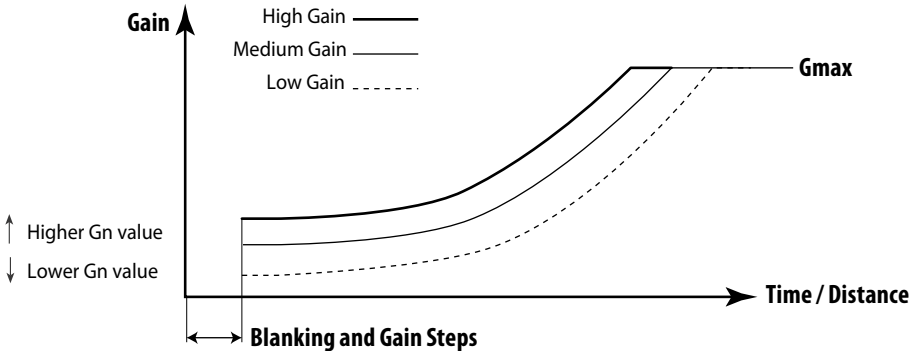
Adjusting the Slope value will affect how fast the Gain rises over the entire span except for that controlled by Gain Steps. The starting Gain is not affected.

Note: The lower the Slope Value, the steeper the Gain Curve is. The Slope value is a distance in the selected units (metres or feet).
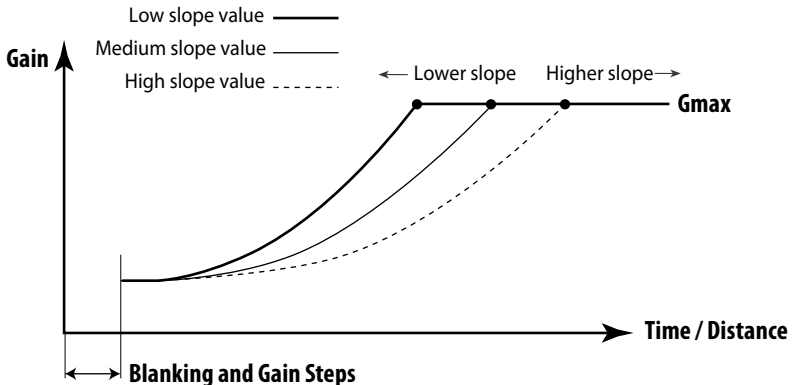
RECOVER ADJUSTMENT

RECOVER ADJUSTMENT

Gain changes automatically from Basic Gain Curve to include additional Recover Gain when neccessary.

Changes occur in small increments to a maximum of the Recovery value.
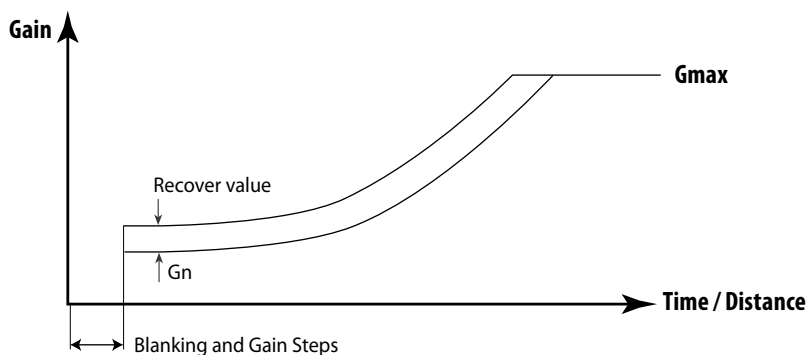
SETTING THE SYSTEM

Things to check

Check S value if less than approximately 1 volt increase Gn setting by 10%. The echo size should be at least 2.0 volts. Remember - anything above the Threshold value closest to the sensor will be the displayed E distance.

1 | **DISPLAY DISTANCE CLOSER THAN ACTUAL LEVEL**

If the distance displayed is incorrect and a closer distance than the level echo heading go to Map and map to a distance 10% (min) past the unwanted echo.

If the incorrect displayed distance has a signal size greater than 1.0 volt it is recommended to move the sensor until the

unwanted echo is less than 0.5 volts. The larger the size of the unwanted echo, the less is the likelyhood of smooth transition through this point when the level reaches this distance.

The mapped echo must be smaller than the actual level. A rule of thumb is the level echo should be double the return echo signal voltage size compared to the mapped unwanted echo.

Echo Size Volts

Incorrect Echo: 2.0m
Correct Echo: 3.8m

E2

E1

Threshold Value

Distance(m)

2.0m   **3.8m**
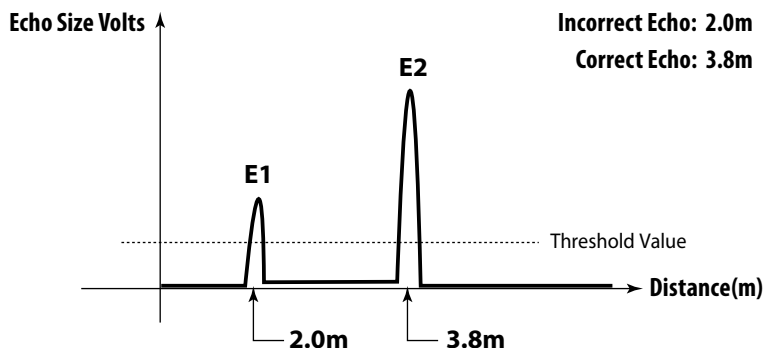
E1 is the incorrect distance.

Ensure the signal size S: is less than 1.0 volts - if neccessary move the transducer when **E1** S value is less than 1.0V map to 2.2m.

To eliminate E1 from being considered as an echo when filling occurs at **E2** is co-incident with E1 position. **E2**

SETTING THE SYSTEM
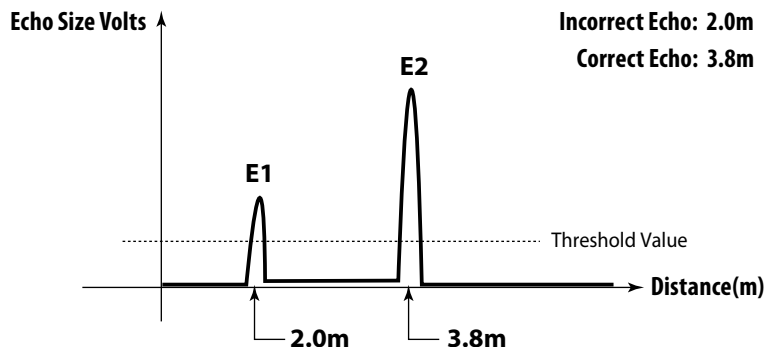
E2 is more than double the size of **E1**, hence it is possible to monitor and follow **E2** at this **E1** mapped distance.

Note: It would be possible to increase the threshold value to a number greater than the **E1** signal S: value **E1** then would be smaller than the threshold hence cannot be seen by the software as a potential level echo.

SETTING THE SYSTEM

---

2   DISPLAY DISTANCE FURTHER THAN ACTUAL LEVEL

If the distance displayed is greater than the actual level, increase **Gn** until the distance is displayed, on the diagnostic **E: value** then go to **S: value** and increase **Gn** to read an approximate **S: value** of 2.0 volts.

Echo Size Volts

E1 Actual Level

E2 Reflected larger echo

E2

E1

············· Threshold Value

Distance(m)
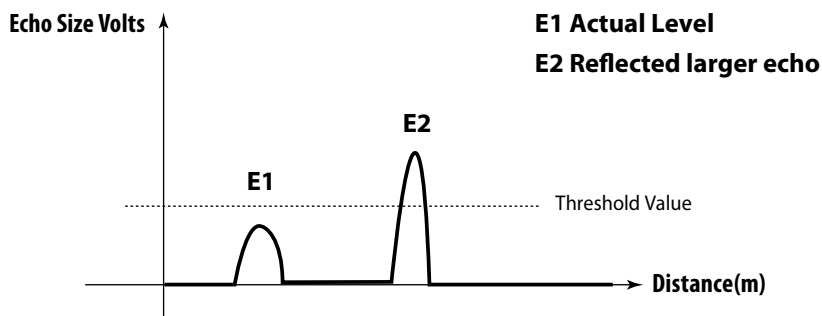
By increasing **Gn**, it is possible to then monitor the correct level echo.

Echo Size Volts

E1 Actual Level

E2 Reflected larger echo

E2

E1

············· Threshold Value

Distance(m)
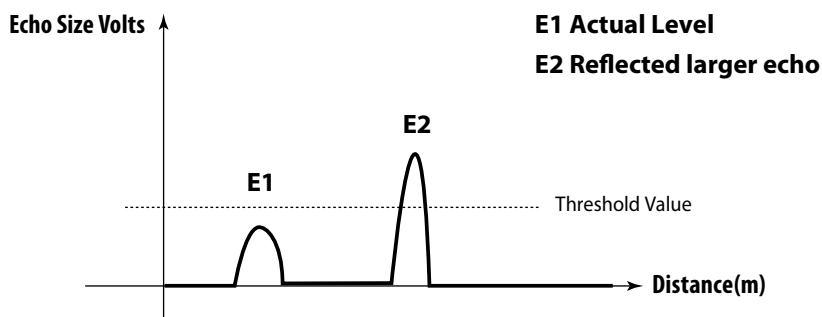
Note: It would be possible to lower the Threshold Value to ensure **E1** is larger than the Threshold Value

---

SPECIAL APPLICATION SETUP EXAMPLES

Diesel Tank

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.300	Recover First(%):	0.0	Gain(%):	30.0	Low Level(m):	12.620
Type:		Slope Inc(%):	0.7	Recover Max(%):	0.0	Gain Step 3(%):	24.0	Hi Level(m):	0.429
SoftVer:		Detector:		Recover Inc.(%):	0.1	Dist Step 3(m):	0.900	Application:	Liquids
ModbusID:		GainStep1(%):	2.7	Window(m):	0.160	Threshold:	0.40	Rate of Fill:	0.3
Tx Serial No:		DistStep1(m):	0.350	Win Fwd(m):	0.001	Blanking(m):	0.400	Damp Fill:	100
Tx Model No:	20	GainStep2(%):	15.1	Win Back(m):	0.001	EmptyDist(m):	30.000	Rate of Empty:	0.3
Tx SoftVer:		DistStep2(m):	0.500	Confirm:	2	Temp Adj:		Damp Empty:	100
Tx ModbusID:		GainMax(%):		Hold:	40	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 20 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Material
		Filter:		Search First(%):	0.0	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter	96	No of Echo:					
		I-Charge:							

1. Do not change fields with no values shown
2. Circled - Values shown are suited only for the example application.
   Set according to your application specifics.

Ash Pit

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.300	Recover First(%):	14.9	Gain(%):	34.9	Low Level(m):	9.420
Type:		Slope Inc(%):	0.7	Recover Max(%):	14.9	Gain Step 3(%):	20.0	Hi Level(m):	3.420
SoftVer:		Detector:		Recover Inc.(%):	0.1	Dist Step 3(m):	1.200	Application:	Liquids
ModbusID:		GainStep1(%):	2.7	Window(m):	1.000	Threshold:	0.40	Rate of Fill:	10.0
Tx Serial No:		DistStep1(m):	0.350	Win Fwd(m):	0.100	Blanking(m):	1.200	Damp Fill:	15
Tx Model No:	20	GainStep2(%):	14.9	Win Back(m):	0.100	EmptyDist(m):	30.000	Rate of Empty:	10.0
Tx SoftVer:		DistStep2(m):	0.500	Confirm:	2	Temp Adj:		Damp Empty:	8
Tx ModbusID:		GainMax(%):		Hold:	10	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 20 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Material
		Filter:		Search First(%):	0.0	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter	96	No of Echo:					
		I-Charge:							

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SPECIAL APPLICATION SETUP EXAMPLES

Sewer Pump Station

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.300	Recover First(%):	4.0	Gain(%):	18.0	Low Level(m):	7.000
Type:		Slope Inc(%):	0.7	Recover Max(%):	4.0	Gain Step 3(%):	18.0	Hi Level(m):	0.500
SoftVer:		Detector:		Recover Inc.(%):	0.1	Dist Step 3(m):	0.900	Application:	Liquids
ModbusID:		GainStep1(%):	2.7	Window(m):	0.200	Threshold:	0.40	Rate of Fill:	10.0
Tx Serial No:		DistStep1(m):	0.350	Win Fwd(m):	0.010	Blanking(m):	0.320	Damp Fill:	10
Tx Model No:	20	GainStep2(%):	15.1	Win Back(m):	0.010	EmptyDist(m):	30.000	Rate of Empty:	10.0
Tx SoftVer:		DistStep2(m):	0.500	Confirm:	2	Temp Adj:		Damp Empty:	10
Tx ModbusID:		GainMax(%):		Hold:	10	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 20 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Matrl%
		Filter:		Search First(%):	0.0	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter:	96	No of Echo:					
		I-Charge:							

1. Do not change fields with no values shown
2. Circled - Values shown are suited only for the example application.
   Set according to your application specifics.

Heavy Medium Sump

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.450	Recover First(%):	0.0	Gain(%):	20.0	Low Level(m):	6.000
Type:		Slope Inc(%):	0.7	Recover Max(%):	30.0	Gain Step 3(%):	12.0	Hi Level(m):	0.500
SoftVer:		Detector:		Recover Inc.(%):	1.5	Dist Step 3(m):	0.750	Application:	Slurry
ModbusID:		GainStep1(%):	1.1	Window(m):	1.000	Threshold:	0.50	Rate of Fill:	50.0
Tx Serial No:		DistStep1(m):	0.500	Win Fwd(m):	0.100	Blanking(m):	0.500	Damp Fill:	20
Tx Model No:	15	GainStep2(%):	8.0	Win Back(m):	0.150	EmptyDist(m):	30.000	Rate of Empty:	51.0
Tx SoftVer:		DistStep2(m):	0.700	Confirm:	2	Temp Adj:		Damp Empty:	20
Tx ModbusID:		GainMax(%):		Hold:	10	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 15 kHz		Frequency:		Echo Width(m):	0.100	MapUsed(m):		Disp Mode:	Space
		Filter:		Search First(%):	2.4	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter:	64	No of Echo:					
		I-Charge:							

1. Do not change fields with no values shown
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   Set according to your application specifics.

SPECIAL APPLICATION SETUP EXAMPLES

Primary Jaw Crusher

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.300	Recover First(%):	0.0	Gain(%):	32.0	Low Level(m):	2.700
Type:		Slope Inc(%):	0.7	Recover Max(%)	0.0	Gain Step 3(%):	24.0	Hi Level(m):	2.000
SoftVer:		Detector:		Recover Inc.(%):	0.3	Dist Step 3(m):	0.900	Application:	Solids
ModbusID:		GainStep1(%):	2.7	Window(m):	2.000	Threshold:	0.40	Rate of Fill:	100.0
Tx Serial No:		DistStep1(m):	0.350	Win Fwd(m):	1.000	Blanking(m):	1.600	Damp Fill:	4
Tx Model No:	20	GainStep2(%):	15.1	Win Back(m):	1.000	EmptyDist(m):	30.000	Rate of Empty:	100.0
Tx SoftVer:		DistStep2(m):	0.500	Confirm:	2	Temp Adj:		Damp Empty:	4
Tx ModbusID:		GainMax(%):		Hold:	10	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 20 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Space
		Filter:		Search First(%):	2.4	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter:	64	No of Echo:					
		I-Charge:							

1. Do not change fields with no values shown
2. Circled - Values shown are suited only for the example application.
Set according to your application specifics.

Secondary Crusher

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.300	Recover First(%):	0.0	Gain(%):	36.0	Low Level(m):	3.300
Type:		Slope Inc(%):	0.7	Recover Max(%)	0.0	Gain Step 3(%):	30.0	Hi Level(m):	1.100
SoftVer:		Detector:		Recover Inc.(%):	0.1	Dist Step 3(m):	1.500	Application:	Solids
ModbusID:		GainStep1(%):	2.7	Window(m):	2.000	Threshold:	0.40	Rate of Fill:	100.0
Tx Serial No:		DistStep1(m):	0.350	Win Fwd(m):	1.000	Blanking(m):	1.500	Damp Fill:	4
Tx Model No:	20	GainStep2(%):	15.1	Win Back(m):	1.000	EmptyDist(m):	30.000	Rate of Empty:	100.0
Tx SoftVer:		DistStep2(m):	0.900	Confirm:	2	Temp Adj:		Damp Empty:	4
Tx ModbusID:		GainMax(%):		Hold:	10	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 20 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Space
		Filter:		Search First(%):	0.0	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter:	64	No of Echo:					
		I-Charge:							

1. Do not change fields with no values shown
2. Circled - Values shown are suited only for the example application.
Set according to your application specifics.

SPECIAL APPLICATION SETUP EXAMPLES

Surge Bin

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.086	Recover First(%):	25.1	Gain(%):	14.9	Low Level(m):	14.800
Type:		Slope Inc(%):	0.1	Recover Max(%)	25.3	Gain Step 3(%):	16.0	Hi Level(m):	1.000
SoftVer:		Detector:		Recover Inc.(%):	0.3	Dist Step 3(m):	1.500	Application:	Solids
ModbusID:		GainStep1(%):	2.7	Window(m):	3.000	Threshold:	0.40	Rate of Fill:	90.2
Tx Serial No:		DistStep1(m):	0.550	Win Fwd(m):	0.200	Blanking(m):	1.000	Damp Fill:	6
Tx Model No:	10	GainStep2(%):	8.0	Win Back(m):	0.150	EmptyDist(m):	18.000	Rate of Empty:	63.5
Tx SoftVer:		DistStep2(m):	0.850	Confirm:	2	Temp Adj:		Damp Empty:	6
Tx ModbusID:		GainMax(%):		Hold:	8	Dist Adj(m):		Failsafe:	4.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 10 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Matrl%
		Filter:		Search First(%):	0.0	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter:	96	No of Echo:					
		I-Charge:							

1. Do not change fields with no values shown
2. Circled - Values shown are suited only for the example application.
   Set according to your application specifics.

ROM Bin

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.800	Recover First(%):	5.1	Gain(%):	20.0	Low Level(m):	14.000
Type:		Slope Inc(%):	0.7	Recover Max(%)	5.1	Gain Step 3(%):	16.0	Hi Level(m):	5.000
SoftVer:		Detector:		Recover Inc.(%):	0.1	Dist Step 3(m):	4.500	Application:	Solids
ModbusID:		GainStep1(%):	2.7	Window(m):	5.000	Threshold:	0.30	Rate of Fill:	300.0
Tx Serial No:		DistStep1(m):	0.550	Win Fwd(m):	1.000	Blanking(m):	4.500	Damp Fill:	5
Tx Model No:	10	GainStep2(%):	8.0	Win Back(m):	0.100	EmptyDist(m):	25.000	Rate of Empty:	300.0
Tx SoftVer:		DistStep2(m):	1.500	Confirm:	2	Temp Adj:		Damp Empty:	5
Tx ModbusID:		GainMax(%):		Hold:	20	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 10 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Matrl%
		Filter:		Search First(%):	0.0	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter:	96	No of Echo:					
		I-Charge:							

1. Do not change fields with no values shown
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SPECIAL APPLICATION SETUP EXAMPLES

Coal on Belt Detector

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.050	Recover First(%):	0.0	Gain(%):	30.0	Low Level(m):	1.154
Type:		Slope Inc(%):	0.7	Recover Max(%)	0.0	Gain Step 3(%):	26.0	Hi Level(m):	0.839
SoftVer:		Detector:		Recover Inc.(%):	0.4	Dist Step 3(m):	0.700	Application:	Solids
ModbusID:		GainStep1(%):	2.7	Window(m):	6.000	Threshold:	0.40	Rate of Fill:	150.0
Tx Serial No:		DistStep1(m):	0.350	Win Fwd(m):	0.500	Blanking(m):	0.700	Damp Fill:	1
Tx Model No:	20	GainStep2(%):	15.1	Win Back(m):	0.500	EmptyDist(m):	10.000	Rate of Empty:	150.0
Tx SoftVer:		DistStep2(m):	0.500	Confirm:	1	Temp Adj:		Damp Empty:	1
Tx ModbusID:		GainMax(%):		Hold:	40	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 20 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Space
		Filter:		Search First(%):	0.0	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter	64	No of Echo:					
		I-Charge:							

1. Do not change fields with no values shown
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Cement Silo

Info		Factory		Track		Tx Setup		Quick Start	
Serial No:		Slope Dist(m):	0.400	Recover First(%):	22.0	Gain(%):	24.0	Low Level(m):	15.500
Type:		Slope Inc(%):	0.7	Recover Max(%)	22.0	Gain Step 3(%):	24.0	Hi Level(m):	1.500
SoftVer:		Detector:		Recover Inc.(%):	0.1	Dist Step 3(m):	2.600	Application:	Solids
ModbusID:		GainStep1(%):	1.3	Window(m):	1.500	Threshold:	0.20	Rate of Fill:	0.6
Tx Serial No:		DistStep1(m):	1.350	Win Fwd(m):	0.002	Blanking(m):	1.500	Damp Fill:	600
Tx Model No:	05	GainStep2(%):	10.0	Win Back(m):	0.004	EmptyDist(m):	65.500	Rate of Empty:	3.3
Tx SoftVer:		DistStep2(m):	2.200	Confirm:	2	Temp Adj:		Damp Empty:	24
Tx ModbusID:		GainMax(%):		Hold:	24	Dist Adj(m):		Failsafe:	20.00mA
		PulsePwr:		Tx Voltage:		Velocity:		Fail Safe Time:	180
		PulseRate:		Noise Sw(%):		MapDist(m):		Lock Code:	0
Use 5 kHz		Frequency:		Echo Width(m):	0.030	MapUsed(m):		Disp Mode:	Matrl%
		Filter:		Search First(%):	0.0	MapMargin(%):			
		I-Waste:		Movement(m):					
		AdvFilter	96	No of Echo:					
		I-Charge:							

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SOFTWARE MENUS - ENTERING DATA

All software adjustments are achieved via the four PUSHBUTTONS on the front panel of the Sultan amplifier.

FROM MAIN DISPLAY

CAL

(A) Press and hold - interups normal operations and allows access to customised options.
Changes headings and allows EDIT function to occur.

IN SET-UP
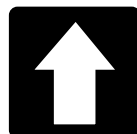
(B) Momentary press – saves selected value.
Press and hold – scrolls through set-up menus and parameters.

(A) Increases displayed value.

(B) Scrolls up through software set-up options.

(A) Decreases displayed value.

(B) Scrolls up through software set-up options.

RUN

(A) Only used when selections are finished.

(B) Stores the current set-up in memory, and checks the validity of the software selections, then returns the Sultan to normal operating condition.

Use these 4 buttons along with the 'software tree' to customise the Sultan for your application.

SOFTWARE MENUS - ENTERING DATA

SOFTWARE

```
        ┌─────────────┐
        │    Space    │
        │   5.72m     │
        └─────────────┘
              CAL
        ┌─────────────┐
        │   Unlock    │
        │      0      │
        └─────────────┘
              CAL
        ┌─────────────┐
   ┌──▶│  QuickSet   │
   │    └─────────────┘
   │         ⬆
   │         ⬇
   │    ┌─────────────┐
   │    │ Output  Adj │   Code 0
   │    └─────────────┘
   │         ⬆
   │         ⬇
   │    ┌─────────────┐
   │    │  Tx  Set  Up │   Code 0
   │    └─────────────┘
   │         ⬆
   │         ⬇
   │    ┌─────────────┐
   └────│  Tracking   │   Code 195
        └─────────────┘
```
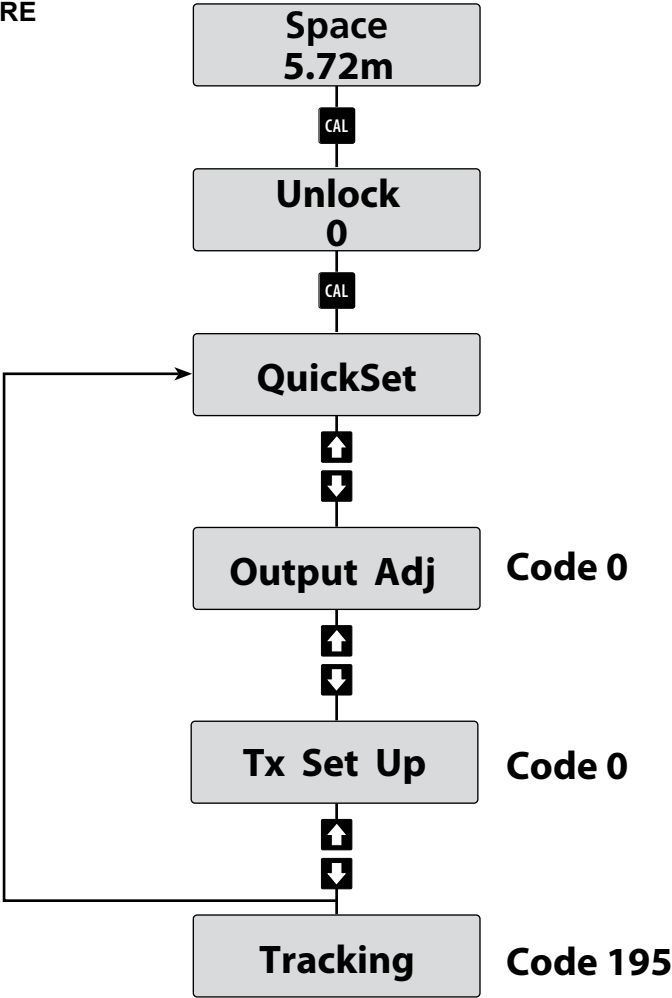
*Press **RUN** button twice to revert to normal operation.

SOFTWARE MENUS - ENTERING DATA - Diagnostic Display

(1) Go to **Quickset** and enter the values for the specific application. When finished press **RUN** twice.

(2) Go to diagnostic display, the display should show.

> **Space**
> **X.XXm**

If you press the ⬆⬇ pushbuttons the following diagnostic are shown.

> **Space**
> **4.221m**   **Damped distance**

⬆⬇ **E:**   **4.2**   Instant echo distance

⬆⬇ **S:**   **1.11V**   Echo size in volts

⬆⬇ **Gn:**   **37.6%**   Gain at distance echo is detected

⬆⬇ **R:**   **0.0%**   The amount of gain to recover if the echo is less than threshold detection voltage level

⬆⬇ **N:**   **1.9%**   Noise value

⬆⬇ **T:**   **23.2°C**   Temperature at sensor face

⬆⬇ **W**   ⬆   **2.0m**   Window starting distance

⬆⬇ **W**   ⬇   **2.4m**   Window finishing distance

⬆⬇ **Normal**   Normal or recover. Normal if echo is above threshold, Recover if below threshold

ENTERING DATA - Volume Adjustment

Volume Menu

Volume Menu is used to calculate the volume based on the material Level for different vessel shapes. The calculated (Level, Volume) table can be read from or written to a Sultan unit with amplifier software version above or equal to 3.72.

Volume Parameter Definitions

LowLevel = Distance from the Face of the transducer that corresponds to the low level in the vessel (4mA Analog output).
HiLevel = Distance from the face of the transducer that corresponds to the high level in the vessel (20mA analog output).
h3 = Distance from the face of the transducer to the top of the vessel.
h2 = Total height of the vessel.
h1 = Height of the bottom section (cone or pyramid base).
d = Diameter of the Cylinder Section.
d2 = Diameter of the Cone Base at the bottom.
w = Width of the rectangular section.
L = Breadth of the rectangular section.
MaxVolume = Maximum Calculated Volume of the Vessel.
Density = Density of the material inside the vessel.
Full Scale Value (FSV) = Maximum Capacity of the Vessel.

Volume User Guide

1. Choose the Vessel Shape.
2. Set the LowLevel and HiLevel according to your application.
3. Set the Vessel parameters such as L, w, d and h1. Refer to the vessel figure for the definition of each parameter.

4. Set the values of h2 and h3 if required (optional). Tick the Enabled box to modify h2 and h3. By default h3=HiLevel and h2=(LowLevel - HiLevel).
5. Choose the Volume unit.
6. Enter Density or Full Scale values if necessary (optional).

*Full Scale Value (FSV) = MaxVolume * Density*

In the above equation, MaxVolume is calculated by software and can not be modified. The user may enter Density or FSV to determine the other parameter.

7. Except the critical points that are shown with red colour, any pair of (Level, Volume) points can be modified. Double Click on the points to modify.
8. Click on Write Volume to write the Level/ Volume table to the unit. This also saves the application setting to the database.
To write successfully, unit must be on RUN mode and amplifier software version must be 3.72 or above.
9. After writing to the unit, make sure that the display of the unit changes to Volume and the volume unit shown on the display is the same as what you selected from GosHawk.
10. Click on Read Volume to read the volume table from the unit if required.

ENTERING DATA - Volume Adjustment

Here is an example how to program Sultan with Volume:

1. Choose Vessel Shape Cylinder as show in Figure below:
2. Set LowLevel to 5.6
3. Set Hi Level to 0.5
4. Set diameter to 3.020
5. Do not select Optional Parameter. Make sure that Enable is not selected in optional parameters
6. The Max Volume that is calculated by GoshawkII should be 36.531 as shown below.
7. Set the FSV to 200
8. Choose Cubic Meter as Volume Unit
9. Click on Write to write the Volume to the unit.
10. Now Face the transducer to a target at space = 1.709 meter
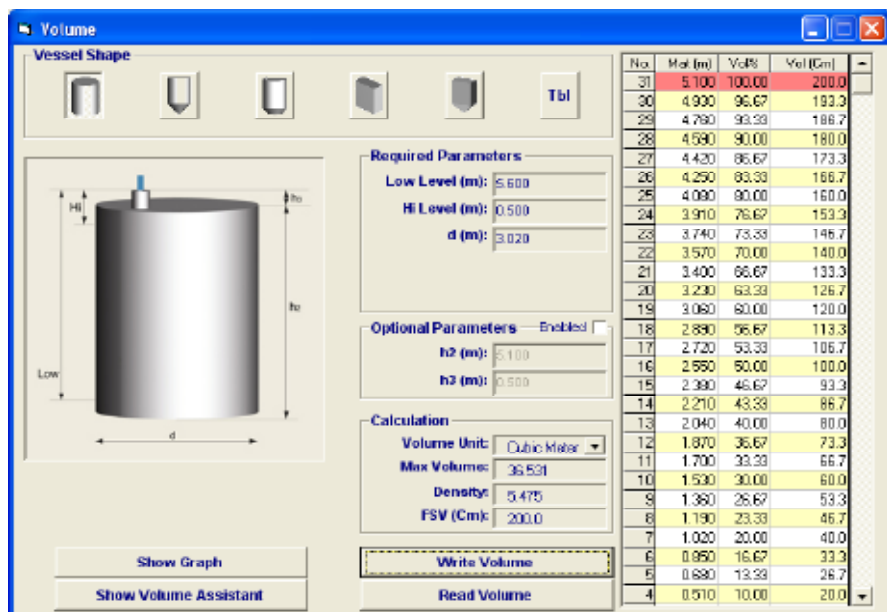
Figure 1: Volume

SOFTWARE MENUS - ENTERING DATA - Volume Adjustment

Now let's calculate the Volume

Low Level – Space = 5.6 – 1.709 = 3.891, which is between point 23 (3.740) and point 24 (3.910), Vol at point 23 is 146.7, Vol at point 24 is 153.3, therefore, our Vol shown on Tank View should between 146.7 and 153.3

- Volume shown on figure 2 is 152.6 which is between 146.7 and 153.3

- Check the Sultan unit display, Volume shown is 152.6cm

	Mat	Vol %	Vol
Point 24	3.910	76.67	153.3
Point show on LED	3.891	76.29	152.6
Point 23	3.740	73.33	146.7

- Ok, let's calculate this Volume by ourself:

Vol % = Mat / (LowLevel – HiLevel) * 100% = 3.891 / (5.6 – 0.5) * 100% = 76.29%
Vol = FSV * Vol% = 200 * 76.29% = 152.58 ->> 152.6

- Therefore, the Vol shown on Tank View form is the same as Vol shown on Sultan display, and is the Volume level filled in the tank.

Figure 2: Volume shown in Tank View form

SOFTWARE MENUS - SETUP - Quickset

QUICKSET

To gain access to the parameter menu, press and hold the ▣ button until "Unlock 0" is displayed on the LCD. Then use the ⬆️⬇️ buttons to select the access code. The factory default is 0.

Code

Allows the user to set an access code other than 0 to avoid unauthorised changes to the programming. Use the ⬆️⬇️ buttons to select the desired access code.

Units

Allows the user to select the units for display of measured distances and relay set point programming. The choices are metres/centimetres or feet/inches.

Low Level

Sets the distance from the face of the transducer that corresponds to the low level in the vessel being monitored -4mA analog output level.

High level

Sets the distance from the face of the transducer that corresponds to the High level in the vessel being monitored - 20mA analog output level.
Note: When setting the High and Low levels a minimum span of 100mm MUST be maintained.

Fail Time

Allows the user to enter the number of pulses when a last echo condition occurs prior to failing. It is recommended to enter a minimum of 50 pulses.

Fail-safe

Allows the user to select their preferred Fail-safe condition. There are 5 possible mA output failure values. They are: 20mA, 4mA, Last Known, <4.00mA and >20.00mA.

Application Type

Allows the user to select the type of application Liquids, Slurries, Solids. The response of the system is automatically changed to allow for application requirments.

Fill Rate / Emp Rate

Allows the user to select the approximate speed of the level change. This auto-matically sets various parameters to allow a faster or slower response.

Display

Allows the user to select the prefered display on the LCD, options Space, Material, % Material, Flow, Avg Material, Dilhrd P, Flow Tbl, volume

Flow

Allow open channel flow using q=kha.

Flow Unit

Litres, k litres, m litres, Cube ft, Cube mtrs.

Flow Exp.

This is the Expontential of the flume.

Flow Max.

This is the maximum flow for the flume.

Lo Cut Off

This is the value, typically, when the flow is less than 1cm in height it is deemed not to be flowing.

SOFTWARE MENUS - SETUP - Quickset

| QuickSet |
| **CAL** |

Unit — **CAL** — Select unit of measurement from: Feet, Metres, Centimeters, Inches

Low Level — **CAL** — Adjust vessel low level (maximum measured distance from transducer face)

High Level — **CAL** — Adjust vessel high Level (minimum measured distance from transducer face)

Fail Safe — **CAL** — 3.50mA, 3.80mA, 20.20mA, Last Known — **CAL** — **Fail Time** — Adjust Fail time (seconds)

App Type — **CAL** — Position, Slurry, Solids, Liquids — **CAL** — **Fill Rate** — **CAL** — Adjust vessel fill rate

Note: If using GosHawk PC comms, after changing 'app type' you need to reset fill & empty rate to 1 and then enter your preferred values.

Empty Rate — **CAL** — Adjust vessel empty rate

Display Mode — **CAL** — Avg Matrl*, Diff O/P*, Space, Material, Material%, Flow*, Volume, Flow Tbl — *Go to 'Display Modes' on page

1: SenAdd — **CAL** — Sensor Address Default: 1 — **CAL** — **1: TxAdds** — **CAL** — Transducer IDs. Default 1

Offset — **CAL** — Enter distance offset value

AmpReset — **CAL** — Reset Amplifier to default settings. You will be prompted to confirm action

LockCode — **CAL** — Change unlock code (default 0)

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SOFTWARE MENUS - SETUP - TX Setup

Gain (Gn):

This is a settable level which repesents the starting value for the units receiver gain at the beginning of normal control (time varying gain control). This value will take over gain control after the last of the gain limit steps (Gs/Ds). The true effect of this parameter is to increase or decrease gain levels (and echo sizes) at all points on the gain curve, by moving the whole gain curve up or down (as if holding it by its end). This is generally used to increase or decrease the size of echoes across the whole measurement range (except for very close to the transducer, which can be controlled by fixed gain steps if required). Increasing Gain (Gn) has a similar effect to decreasing detection Threshold (Thld) and the reverse is also true.

The result of changes can be seen immediately as the unit pulses during adjustment of this parameter and displays the distance found (in SPACE mode without damping). This parameter is duplicated under the Tracking menu (only seen in code 195). Changes made either here or in Tracking will result in a change to both. It is included twice in order to simplify user access under code 0.

Gain Step (Gs):

This value repsesents the maximum receiver gain (%) at which the unit will operate within a distance of Ds (described below) from the transducer face. Inside this distance the receiver may operate at a lower gain if G1 and/or G2 are set to lower values than Gs, otherwise the unit will operate with a fixed gain value Gs for measurement of distances up to Ds.

Normally Gs and Ds must be considered and adjusted as a pair, and should only need adjustment to assist in masking mounting or transducer related prolems.

The result of changes can be seen immediately as the unit pulses during adjust-ment of this parameter and displays the distance found (in SPACE mode without damping). This parameter is duplicated under the Tracking menu (only seen in code 195). Changes made either here or in Tracking will result in a change to both. It is included twice in order to simplify user access under code 0.

Distance Step (Ds):

This value represents the distance from the transducer face (in metres or feet as per the user selection) over which a gain limit of Gs will be applied. This gain limit can be used to lessen the effect of poor mountings and is the only one of the three gain steps which should be used for field problem correction (G1/D1 and G2/D2 steps are normally only used at default values to hide transmit pulse / ringing).

Normally Gs and Ds must be considered and adjusted as a pair, and should only need adjustment to assist in masking mounting or transducer related problems.

SOFTWARE MENUS - SETUP - TX Setup

The result of changes can be seen immediately as the unit pulses during adjustment of Ds either here or in Tracking will this parameter and displays the distance found (in SPACE mode without damping).This parameter is duplicated under the Tracking menu (only seen in code 195). Changes made result in a change to both. It is included twice in order to simplify user access under code 0.

Thld:

The Thld (Threshold) parameter is a settable size (in Volts), which an echo must reach in order to be detected. The instrument will accept the first echo exceeding the threshold voltage as the correct measured distance. It is the user's responsibility to ensure that correct transducer positioning will always make the first echo detected the true level being measured (it will be if the transducer has a clear "view" of the level and no obstructions). Adjustment of the gain control parameters and threshold parameter can help to select a correct echo from a number of different echoes present. Increasing a threshold value will also increase noise immunity if the echo from the level is sufficiently strong. Do not exceed a setting of 3.00 for Threshold.

The result of changes can be seen immediately as the unit pulses during adjustment of this parameter and displays the distance found (in SPACE mode without damping). This parameter is duplicated under the Tracking menu (only seen in code 195). Changes made either here or in Tracking will result in a change to both. It is included twice in order to simplify

user access under code 0.
e.g: Solids and Powders = 0.5v to 1.75v

Liquids = 0.5v to 2.0v.

DistTrim: (Y/N):

Select Y to access distance calibration parameters.

Velocity:

The Velocity parameter can be used to compensate measurements being taken in gas mixtures other than air. The speed of sound is changed by different gas compositions, so an ultrasonic measurement will be inaccurate by some factor. Variation of this velocity factor until the displayed distance is corrected to a known measured distance will eliminate errors due to the speed of sound differing slightly to that found in air. Note that this kind of compensation can only be effective in a constant atmosphere.

The composition of gases being measured through must be relatively constant with time to maintain accuracy. Continuously changing gas compositions in an atmosphere will reduce accuracy of ultrasonic measurement.

Default value is 1.0000 for a compens-ation factor of 1.0000 (no change from air).

SOFTWARE MENUS - SETUP - TX Setup

TX Set Up	**CAL**

Gain   29.7%   **CAL**   ⬆⬇   **Adjust Gain Gn.** Press **CAL** to initiate single pulse.
Distance to echo will be shown

⬆⬇   **RUN**

Gain Step 21.6%   **CAL**   ⬆⬇   **Adjust Gain Step Gn.** Press **CAL** to initiate single pulse.
Distance to echo will be shown

⬆⬇   **RUN**

Dist Step   0.7m   **CAL**   ⬆⬇   **Adjust Distance Step.** Press **CAL** to initiate single pulse.
Distance to echo will be shown

⬆⬇   **RUN**

Threshold   0.4V   **CAL**   ⬆⬇   **Adjust Threshold Voltage.** Press **CAL** to initiate single pulse.
Distance to echo will be shown

⬆⬇   **RUN**

Blanking   0.25m   **CAL**   ⬆⬇   **Adjust Blanking.** Press **CAL** to initiate single pulse.
Distance to echo will be shown

⬆⬇   **RUN**

Empt Dist   **CAL**   ⬆⬇   **Adjust Empty Disance.** Press **CAL** to initiate single pulse.
Distance to echo will be shown

⬆⬇   **RUN**

Temp Trim   **CAL**   ⬆⬇   **Adjust Temp.** Press **CAL** to initiate single pulse.
Distance to echo will be shown

⬆⬇   **RUN**

Dist Trim   **CAL**

⬆⬇

> ***Press RUN twice to revert to normal operation**

Velocity

⬆⬇

Map Dist   **CAL**   ⬆⬇   **Adjust Map Dist** — **Map Echo**

⬆⬇   **CAL**

Map Used   **CAL**   ⬆⬇   **Adjust Map Used**   ⬆⬇

Map Echo YES / NO

SOFTWARE MENUS - SETUP - Output Adjustment

4mA Adj:

Whilst the display shows '4mA Adj', the analog (4-20mA) current output will be forced to its 4mA state. The actual loop current can be measured with an external meter and calibrated exactly by pressing the **UP** or **DOWN** arrows until the external meter reads exactly 4.000mA. Pressing the **CAL** button will store the calibration in the instruments memory.

Re-Calibration should only be necessary if a complete model reset is performed (in extended Tracking under code 195), or if parts of the electronics assembly are changed in maintenance or repair operations.

20mA Adj:

Whilst the display shows '20mA Adj', the analog (4-20mA) current output will be forced to its 20mA state. The actual loop current can be measured with an external meter and calibrated exactly by pressing the **UP** or **DOWN** arrows until the external meter reads exactly 20.000mA. Pressing the **CAL** button will store the calibration in the instrument is memory. Re-Calibration should only be necessary if a complete model reset is performed (in extended Tracking under code 195), or if parts of the electronics assembly are changed in maintenance or repair operations.

Analog:

4-20/20-4mA The analog current output of the instrument can be set to act in the normal (4-20mA) or reverse (20-4mA) directions. The default condition is 4-20mA, where the furthest distance from the transducer (low level) is output as 4mA, and current increases with filling to the closer (high level) span point of 20mA.

Simulate:

(Y/N): Select **Y** to access measurement simulation mode. In simulation mode, the **UP** and **DOWN** arrow keys vary the distance on the display. The current output and any relays used will behave exactly as they should do if the measured distance (in **SPACE** mode without damping) was that shown on the display. This mode can be used to test correct behavior of outputs, or externally connected equipment.

RELAYS

Allows the user to set the relays for switching. The relays are programmed in a distance from the transducer face to the position where switching is required. Relays work in the following manner:

OFF The relays will remain de-energised regardless of the measured distance or vessel contents.

The relays can be programmed to energise or de-energise depending on the product level in the vessel being monitored.

FS If FS is selected, the relay will operate as a fail safe relay. The relay will be energised at all times and will de-energise if the ultrasonic switch goes in to failsafe condition.

SOFTWARE MENUS - SETUP - Output Adjustment

Output Adj

CAL

Fill Damp — CAL — ⬆⬇ Adjust Damping
000 Min.
999 Max.

⬆⬇

Empty Damp — CAL — ⬆⬇ Adjust Empty Damping

⬆⬇

4mA Adj — CAL — ⬆⬇ Adjust 4.00mA for remote indicator

⬆⬇

20mA Adj — CAL — ⬆⬇ Adjust 20mA for remote indicator

⬆⬇

Analogue 4-20mA — CAL — ⬆⬇ 4-20mA Invert mA output
20mA

⬆⬇

Simulate — CAL — ⬆⬇ Simulate 4-20mA change

⬆⬇

Comms Type — CAL — ⬆⬇ DeviceNet
Profibus
HART
Modbus ➡ See Figure: Comm

⬆⬇

Rly Mode 1 Off — CAL — ⬆⬇ OFF — CAL — FS
En
DEN — CAL

⬆⬇

Rly Mode 2 Off — CAL — ⬆⬇

⬆ RlyL1
⬇ RlyL2 — CAL — ###
(Distance Limit) ⬆⬇

Rly Mode 3 Off — CAL — ⬆⬇ **

⬆⬇ FS
En
DEN — CAL — Edit — ⬆ RlyL1
⬇ RlyL2

Rly Mode 4 Off — CAL — ⬆⬇

⬆⬇

Rly Mode 5 Off — CAL — ⬆⬇

**Relay menu is the same for relays 1-5

***Press RUN twice
to revert to
normal operation**

SOFTWARE MENUS - SETUP - Output Adjustment

TX Charge:

This is the voltage level for the transducer to pulse. Never enter more than 8.000V.

This should not be adjusted.

Window:

Measurements taken by the unit are expected to be able to rise or fall at a known maximum rate defined by the basic setup parameter Speed. The unit uses a window of reasonable width around its last confirmed distance measurement to aid in false echo filtering. Only echoes falling within this window are considered sensible. The window must be set wide enough to accommodate the maximum ex-pected level change between measurement pulses, and also wide enough to be able to lose an echo, due to noise or absorption, for a short time, and still catch it again as signal conditions improve. The echo must still fall inside the window as it returns.

The Window parameter is a distance (in metres or feet as per the user selection) which represents the starting width, either side of its centre point, of the window described above (total window width will be double the value of this parameter). The base window can increase further in size, in increments of the value of the Window parameter in each direction from its centre. This will occur if no echo is found within the window after the Hold period has expired.

Window fwd:

This is the distance per pulse the window will move forward to go to another echo when the unit is in the recover mode.

Window back:

This is the distance per pulse the window will move backwards to go to another echo or when the unit is in the recover mode.

Confirm:

This is the number of times an echo must be above the entered Threshold level before it is considered validated and then after validation the output and display will move ot this new position at a movement dictated by the entered damping number.

EN The relay is normally energised and will de-energise when the product rises above the level determined by L1 and remain de-energised until the product falls below the level determined by L2.

DEN The relay is normally de-energised and will energise when the product rises above the level determined by L1 and remain energised until the product falls below the level determined by L2.

L1 L1 determines the first switch point for relay switching.

L2 L2 determines the second switch point for relay switching.

Note: L1 and L2 are set in the chosen display units relative to the face of the transducer,

DAMPING

Allows the user to define how quickly the switch responds to changes in the measured level within the vessel being monitor ed. A low damping value gives a fast response and a high damping gives a slow response. The damping limits are from 0 to 999. Eg: If you set the damping to a value of 60, the displayed distance will be the average of the last 60 pulses.

SOFTWARE MENUS - FIGURE: Comms

Profibus, DeviceNet, HART, Modbus
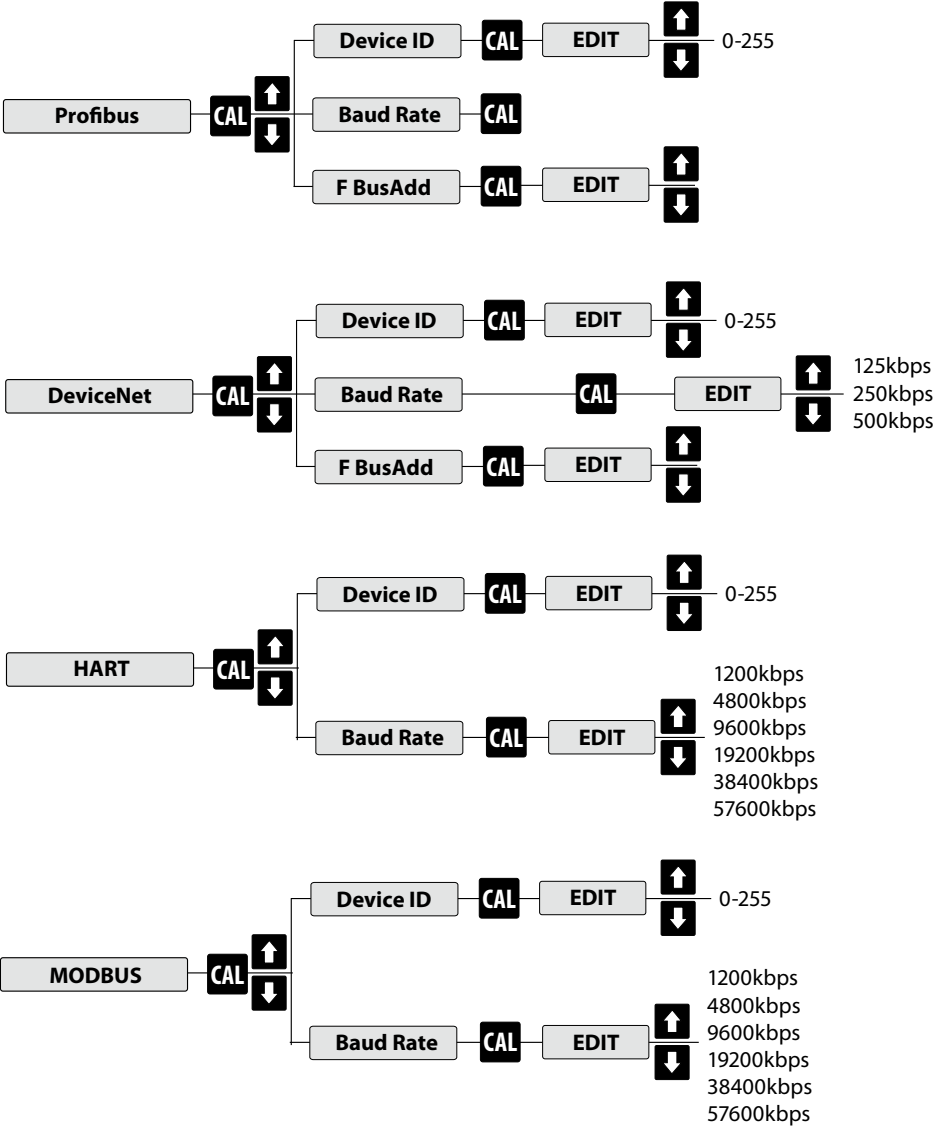
ADVANCED MENUS - Tracking

Unlock 195		Can only be entered by entering **Unlock 195** then press **CAL**
⬆ ⬇		
QuickSet		
⬆ ⬇		
Output Adj		
⬆ ⬇		
Tx Setup		
⬆ ⬇		
Tracking		

CAL

⬆ ⬇
RecovMax — **CAL** — **CAL**

⬆ ⬇
Window — **CAL** — **RUN** — Adjust **Window** Width

⬆ ⬇
Wind Fwd — **CAL** — **CAL**

⬆ ⬇
Wind Back — **CAL** — **CAL** — Adjust **Forward** Movement of window

⬆ ⬇
Confirm — **CAL** — **CAL** — Adjust **Confirm** Number

⬆ ⬇
Hold — **CAL** — **CAL** — Adjust **Hold** Number

⬆ ⬇
Tx Charge — **CAL** — **CAL**

⬆ ⬇
Sens Adds — **CAL** — **CAL**

⬆ ⬇
Movement — **CAL** — **CAL**

*Press RUN twice to revert to normal operation

⬆ ⬇

ADVANCED MENUS - Differential Level
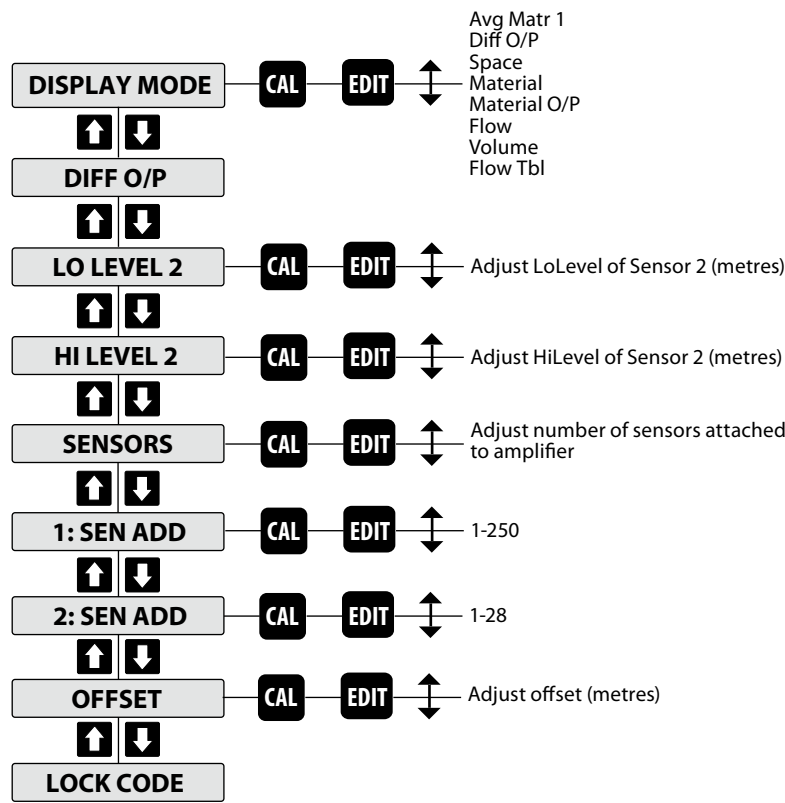
ERROR CODES

ERROR CODE 01 - 04

Error 01: Amplifier can not talk to transducer.

Error 02: Amplifier can talk to transducer but transducer gives incorrect response.

Error 03: ProfiBus or DeviceNet is selected but ProfiBus or DeviceNet module is not connected or responding.

Error 04: Amplifier is programmed with incorrect software.

In general Error Code 01 indicates there is NO communication and Error Code 02 says there IS communication, but not of sufficient quality to be read reliably.

ERROR CODES

Error 01 Information

If Error 01 exists, then the amplifier can not communicate with the transducer, so it is impossible for it to display the address for you (the display cycle for Error 01 does not show any transducer information).

To find the transducer address you must connect directly to the transducer wires, then you will need to use the 'ID Search- Tx ID Search' function of GosHawkII, or the Modscan program and Txfind utility. The BLUE and WHITE transducer communication wires and a Ground connection must be connected to your PC via the RS485 converter. The PC then communicates directly with the transducer, not via the amplifier. The RED and BLACK transducer wires must remain connected to the amplifier terminals. These supply the correct power to the transducer.

The amplifier should be powered ON as normal, then press CAL until the display stops scrolling through the diagnostic messages. Start GosHawkII and use the 'ID Search- Tx ID Search' function. The transducer serial number will appear next to the ID number to which it is currently set. The same thing will occur if you use the Modscan program and Txfind utility.

Record the ID number found, power off, and reconnect the transducer BLUE and WHITE wires to the amplifier terminals, and connect the RS485 converter to the 'A' and 'B' Modbus terminals as normal.

Error 02 Information

Error 02 indicates a communication data corruption between AWA and Transducer. It can be a result of noise in data lines or one of data lines ("A" or "B") being open circuit.

1. Make sure wiring is correct especially look to the screen (earth).

2. If it still doesn't work, you should then disconnect the Transducer from AWA and check modbus ID's of both AWA and Tx through GosHawkII "ID Search".

   If the ID numbers don't match, write down Transducer ID number and then connect AWA to GosHawkII and change it's Modbus ID to recorded value through "Info Screen" window.

3. If the Transducer can't communicate with GosHawkII send it back to Factory for replacement.

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

1. General

The Hawk Sultan Series Acoustic Wave equipment uses high frequency acoustic waves to measure the distance from the sensor face to the material product surface. The equipment is available as an Integral Transmitter or as a Remote system, with an Ex or non-Ex rating.

The AWI series Sultan Acoustic Wave Integral Transmitter models, as well as the AWS series Sultan Smart Transducer models consist of a transducer and an electronic control amplifier in a single housing. They are mounted directly at the level measurement point – usually at the top of a vessel and focused downwards to the product surface. The Integral Transmitter includes a user interface keypad and display, whereas the Smart Transducer is smaller in size and has no user interface except for the communication port.

The Remote Sultan system is one where an AWRT series Sultan Acoustic Wave Remote Transducer is mounted at the level measurement point, and an AWR series Sultan Remote Electronics unit is installed some distance away, in a more convenient location.

The ST Series Sonar transducers are similar to the AWRT series Sultan Acoustic Wave Remote Transducers. They are normally installed submerged in a liquid or slurry rather than in an air medium.

The TE Series and TD Series transducers are alternatives to the AWRT series Sultan Remote Transducer models. Consult the factory or local distributor for application and interface details on these.

2. Category 1 / 2 Equipment Identification

If Hawk Sultan Acoustic Wave equipment is installed and mounted in Category 1 or 2 hazardous areas, these User Manual Safety and Operating Instructions, the general Ex installation regulations and the general installation regulations for electrical equipment must all be observed. The installation of Ex instruments should only be made by trained personnel.

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

a) Intrinsic Safe (Ex ia) rated Equipment for Category 1 Gas and Dust areas (Zone 0)

Sultan AWR, AWI, AWRT, and AWST series equipment models having an Ex ia rating can be identified from information on the additional marking label according to ATEX Type Examination Certificate number ITS04ATEX22807.

Ex II 1 GD   EEx ia IIA T4   IP67
(Tamb = -20ºC to 70ºC)
To be compliant, the equipment must be installed with Intrinsic Barrier devices as described in Intrinsic Safe Installation. Cables from both hazardous and safe areas must be segregated from each other according to the appropriate Intrinsic Safe installation standards. Sonar transducers are rated and marked IP68 for up to 1 metre submersion depth.

b) DIP rated Equipment for Category 1 / 2 Dust areas (Zone 20 / 21)

Sultan AWR, AWI, AWRT, AWST, ST, TE and TD series equipment models having a Dust Ingress Protection rating can be identified from information on the additional marking label according to ATEX Type Examination Certificate number ITS04ATEX12896X.

Ex II 1 D T85ºC   IP67
Tamb = -20ºC to 75ºC
To be compliant, the equipment must be installed with suitable protection for the cable. It must be protected in a suitable manner and terminated in an enclosure suitable for the environment, such as a suitably certified EEx e junction box.

c) Encapsulated (Ex m) rated Equipment for Category 2 Gas and Dust areas (Zone 1, 21)

Sultan AWRT, AWST, ST, TE and TD series equipment models with an Ex m rating can be identified from information on the additional marking label according to ATEX Type Examination Certificate number ITS04ATEX82808X.

Ex II 2 GD   EEx m II
IP68   T6 (Tamb = -20ºC to 50ºC)
T5 (Tamb = -20ºC to 65ºC)
To be compliant, the equipment must be installed with suitable protection for the cable. It must be protected in a suitable manner and terminated in an enclosure suitable for the environment, such as a suitably certified EEx e junction box.

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

d) Non Ex rated Equipment for safe areas:

Sultan equipment without Ex rating can be identified by the fact that only the standard Hawk part number / serial number marking label has been applied. This equipment must only be installed in a safe area. Cables must be protected in a suitable manner and terminated in an enclosure suitable for the environment. Refer also to temperature range in Specifications.

3. Putting Into Service

To put a Hawk Sultan Unit safely into service, the following steps must be taken:

a) Correct installation. Follow the instructions in Typical Installations and Installation Guide.

b) Remote Electronics enclosure conduit entry locations for AWR series models are shown in Dimensions – Remote Enclosure. Remove the terminal cover by loosening the two captive screws. Use a flat blade screwdriver and a slight tap to remove the selected conduit entry openings in the front of the enclosure. Follow the installation instructions in the Installation Guide and Wiring Diagram sections. Be careful to seal any unused cable glands. When wiring is complete, ensure the cable glands are securely sealed against the enclosure and the cable, then seal the terminal cover by tightening the two screws.

c) Integral Transmitter AWI series models have cable glands located at the rear of the housing which face downward to protect against moisture ingress. Ensure that cable glands are securely tightened to adequately seal the cable. Be careful to seal any unused cable glands. The Smart Transducer model AWST has one cable entry point.

d) Correct wiring. Follow the instructions in the Wiring Diagram sections. Wiring should be in accordance with relevant installation standards for hazardous area equipment or other local codes of practice.

e) Safe temperature. Temperature must not exceed the operating range of the Sultan unit. In particular, Ex rated equipment must not exceed the temperature limits stated in Category 1 / 2 Equipment Identification, above.

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

f) Safe power supply. Power supply values must be according to the Specifications.

g) It is advised to provide a cover for the unit to prevent damage that could happen due to environmental conditions.

h) Do not put into service where there is a possibility of contact with acetic acid.

4. Use

The instructions for safe use of the Sultan Unit is as follows:

a) The Sultan equipment must put into service safely. (see Putting Into Service, above).

b) This User Manual must be read and understood by any person involved with the unit.

c) Environment and installation conditions should be checked regularly.

d) When opening the cover of the any Sultan unit, prevent dust, liquids or chemical substances from getting inside the unit. Do not leave any cover open in rain or snow conditions.

e) The LCD display is visible through the clear lid of the AWR series Sultan Remote Electronics enclosure. To view the LCD display on the AWI series Sultan Integral Transmitter, open the visor by lifting up the front edge with a finger. Close and click into place again after viewing so that the display is protected from environmental effects.

f) Before making any wiring or hardware configuration changes, it is important to disconnect power from the equipment.

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

5. Assembling and dismantling

The only assembly that may be required by the user is to reconfigure a Sultan '234' unit (2,3,4 wire operation) to that of a Sultan '2' unit (2 wire operation). This flexibility is unique to Sultan equipment.

To safely reconfigure a Sultan '234' model to that of a Sultan '2' model:

a) Make sure that the original unit is a Sultan '234' model (eg, AWI234 or AWR234). It is not possible to reconfigure a Sultan '2' model (eg, AWI2 or AWR2) as a Sultan 234 model. Only Sultan '234' models can be reconfigured to operate as Sultan '2' models, and this modification is reversible.

b) Disconnect the power to the Sultan '234' Unit.

c) To do the modification, follow the instructions in Wiring – Change Sultan 234 <=> Sultan 2.

d) Modify the wiring to suit the new output configuration as shown in Wiring Diagrams.

6. Installation and Wiring

Carefully follow Typical Installations, Installation Guide and Wiring Diagram sections. Follow all points listed in Putting Into Service, above. Wiring should be in accordance with relevant installation standards for hazardous area equipment or other local codes of practice.

7. Adjustment

a) Sultan Integral AWI series models:

To access the user controls, loosen the single captive screw sufficiently to release the lid. The lid can then be raised to one of two positions – 1) vertical, 2) swung right back [hinge unlocks] to gain access to the cable wiring located under the interior hinged cover flap. To close the lid, ensure that the double hinge at the top of the enclosure is locked into place before re-tightening the lid fastening screw.

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

b) Sultan Remote Electronics AWR series models:

To access the user controls, unlock the clear cover using the lever on the right hand side of the clear lid. Press this lever in the direction of the arrow (towards the lid) to release the catch. The lid can then be swung open to gain access to the user control push buttons. Close the lid when finished. To lock the lid, press on the lower part of the lever, which moves the arrow symbol (in reverse) slightly away from the lid, locking the lid closed.

c) Change of output configuration:

The only other hardware adjustment that may be desired by the user is converting from the Sultan '234' output configuration to the Sultan '2' output configuration. Refer to Assembling and Dismantling, above.

d) Software Adjustment:

For software adjustment of Sultan unit parameter adjustment and data entry, refer to instructions in Entering Data, and all of the Setup sections. If GosHawk II software is to be used for parameter adjustment and data entering from a lap-top computer, read and fully understand the information in the GosHawk II Manual either supplied with the equipment or downloaded free from the Hawk web-site: www.hawkmeasure.com
The AWST series models (with no buttons) can only be adjusted in this way.

8. Application Conditions

a) Voltage Supply:

Must be according to the voltage supplies given in Specifications.

b) Temperature:

Must not exceed the operating temperature range stated in Putting Into Service, above. To prevent inaccuracies due to extremes in temperature and the effect of long term UV exposure, it is recommended that transducers constructed with grey/beige polypropylene housing material be protected from direct sunlight. This does not apply to the blue/green and dark grey plastic enclosure parts. These parts have better UV stability.

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

c) Cable Connection:

Cables must only be replaced by the same cable type. If extending the cable, it must be protected in a junction box and terminated in an enclosure suitable for the environment. Refer to Wiring Diagrams – Transducer.

d) Earthing:

Hawk Sultan Acoustic Wave equipment must be earthed to ensure that shielded cabling is effective.

e) Electrostatic Discharge:

Hawk Sultan Acoustic Wave equipment has been certified safe to use in hazardous dust locations. Marking labels for Ex ia and Ex m equipment warn not to rub the surface with a dry cloth if equipment is installed in hazardous gas locations.

f) Industrial Conditions:

This equipment is designed for use in normal industrial conditions relating to humidity, vibration, etc. If the user intends to operate the equipment in more severe environmental conditions, the manufacturer or local distributor should be consulted for advice.

9. List of equipment types: **Approvals**

Sultan Acoustic Wave Remote Electronics	– AWR series	I,D
Sultan Acoustic Wave Remote Sonar Electronics	– AWR Sonar Series	I,D
Sultan Acoustic Wave Remote Position Electronics	– AWR Position Series	I,D
Sultan Acoustic Wave Remote Transducer	– AWRT series	I,D,M
Sultan Acoustic Wave Remote Sonar Transducer	– AWRT Sonar Series	I,D,M
Sultan Acoustic Wave Integral Transmitter	– AWI series	I,D
Sultan Acoustic Wave Integral Sonar Transmitter	– AWI Sonar Series	I,D
Sultan Acoustic Wave Integral Position Transmitter	– AWI Position Series	I,D
Sultan Acoustic Wave Smart Transducer	– AWST series	D,M
Sultan Acoustic Wave Smart Position Transducer	– AWST Position Series	D,M
Sultan Acoustic Wave Smart Sonar Transducer	– AWST Sonar Series	D,M
TE Series Transducer		D,M
TD Series Transducer		D,M
ST Series Transducer		D,M
Flange Selection		I,D,M
Cone Selection		I,D,M
Extras		I,D,M

Approval codes: I = Ex ia, D = DIP,   M = Ex m

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

10.   Intrinsic Safe Input / Output Parameters, IS barrier types.
Note: All equipment in Zone 0 Hazardous area must have ATEX Cat 1 marking.

A. 2-wire Integral Transmitter in Zone 0 Hazardous area.
I.S. Barrier(s) connected between Transmitter and control system.

Current Loop Input:
U_i = 28 Volts
I_i = 93 mA
P_i = 0.66 W
C_i = 0
L_i = 0
Barrier Eg, MTL 7787+

Optional Communication to PLC/DCS:
U_i = 9 Volts
I_i = 120 mA
P_i = 0.54 W
C_i = 0
L_i = 0
U_o = 5.9 Volts
I_o = 1.13 Amps
P_o = 0.66 W
C_o = 1000 µF
L_o = 223 µH
L/R Ratio = 170 µH/Ω
Barrier Eg, MTL 7758+

B. 2-wire Remote Amplifier in Zone 0 Hazardous area and Transducer in Zone 0 Hazardous area.
I.S. Barrier(s) connected between Amplifier and control system.

Current Loop Input:
U_i = 28 Volts
I_i = 93 mA
P_i = 0.66 W
L_i = 0
C_i = 0
Barrier Eg, MTL 7787+
Barrier Eg, MTL 7766Pac

Optional Communication to PLC/DCS:
U_i = 9 Volts
I_i = 120 mA
P_i = 0.54 W
C_i = 0
L_i = 0
U_o = 5.9 Volts
I_o = 1.13 Amps
P_o = 0.66 W
C_o = 1000 µF
L_o = 223 µH
L/R Ratio = 170 µH/Ω
Barrier Eg, MTL 7758+

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

C. 2-wire Remote Amplifier in Safe area and Transducer in Zone 0 Hazardous area.
I.S. Barriers connected between Transducer and Amplifier.

Transducer Power: from Remote Amplifier
Uo = 12.6 Volts
Io = 2.41 Amps
Po = 1.2 W
Co = 13.5 μF
Lo = 25 μH
L/R Ratio = 37.5 μH/Ω
Barrier Eg, MTL 7766Pac

Essential Communication to Transducer:
Ui = 9 Volts
Ii = 120 mA
Pi = 0.54 W
Ci = 0
Li = 0
Uo = 5.9 Volts
Io = 1.13 Amps
Po = 0.66 W
Co = 1000 μF
Lo = 223 μH
L/R Ratio = 170 μH/Ω
Barrier Eg, MTL 7758+

SAFETY INSTRUCTIONS

HAWK SULTAN SERIES

Intrinsic Safe Input / Output Parameters, IS barrier types (cont.)

Note: All equipment in Zone 0 Hazardous area must have ATEX Cat 1 marking

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D. **3&4-wire Integral Transmitter in Zone 0 Hazardous area. [DC pwr only, Relays = 0]**
I.S. Barriers connected between Transmitter and control system.

Power Supply:

$Ui = 28$ Volts
$Ii = 93$ mA
$Pi = 0.66$ W
$Ci = 0$
$Li = 0$
Barrier Eg, MTL 7787+

Optional Current Loop
Supply Output: (I_S terminal)

$Uo = 25.2$ Volts
$Io = 0.482$ Amps
$Po = 0.66$ W
$Co = 2.9$ μF
$Lo = 1.22$ mH
L/R Ratio = 93 μH/Ω

Current Loop Output:
(I+ terminal)

$Ui = 28$ Volts
$Ii = 93$ mA
$Pi = 0.66$ W
$Li = 0$
$Ci = 0$

Barrier Eg, MTL 7787+

Optional
PLC Communication:

$Ui = 9$ Volts
$Ii = 120$ mA
$Pi = 0.54$ W
$Ci = 0$
$Li = 0$
$Uo = 5.9$ Volts
$Io = 1.13$ Amps
$Po = 0.66$ W
$Co = 1000$ μF
$Lo = 223$ μH
L/R Ratio = 170 μH/Ω

Barrier Eg, MTL 7758

E. **3&4-wire Remote Amplifier in Zone 0 Hazardous area [DC power only, Relays = 0]**
     and Transducer also in Zone 0 Hazardous area.
I.S. Barriers connected between Remote Amplifier and control system.

Power Supply:

$Ui = 28$ Volts
$Ii = 93$ mA
$Pi = 0.66$ W
$Ci = 0$
$Li = 0$
Barrier Eg, MTL 7787+

Optional Current Loop
Supply Output: (I_S terminal)

$Uo = 25.2$ Volts
$Io = 0.482$ Amps
$Po = 0.66$ W
$Co = 2.9$ μF
$Lo = 1.22$ mH
L/R Ratio = 93 μH/Ω

Current Loop Output:
(I+ terminal)

$Ui = 28$ Volts
$Ii = 93$ mA
$Pi = 0.66$ W
$Li = 0$
$Ci = 0$

Barrier Eg, MTL 7787+

Optional
PLC Communication:

$Ui = 9$ Volts
$Ii = 120$ mA
$Pi = 0.54$ W
$Ci = 0$
$Li = 0$
$Uo = 5.9$ Volts
$Io = 1.13$ Amps
$Po = 0.66$ W
$Co = 1000$ μF
$Lo = 223$ μH
L/R Ratio = 170 μH/Ω

Barrier Eg, MTL 7758

F. **3&4-wire Remote Amplifier in Safe area [DC power only, Relays = 0]**
     and Transducer in Zone 0 Hazardous area.
I.S. Barriers connected between Transducer and Remote Amplifier.

Transducer Power from Remote Amplifier

$Uo = 12.6$ Volts
$Io = 2.41$ Amps
$Po = 1.2$ W
$Co = 13.5$ μF
$Lo = 25$ μH
L/R Ratio = 37.5 μH/Ω

Barrier Eg, MTL 7766Pac

Essential Communication
To Transducer

$Ui = 9$ Volts
$Ii = 120$ mA
$Pi = 0.54$ W
$Ci = 0$
$Li = 0$
$Uo = 5.9$ Volts
$Io = 1.13$ Amps
$Po = 0.66$ W
$Co = 1000$ μF
$Lo = 223$ μH
L/R Ratio = 170 μH/Ω

Barrier Eg, MTL 7758

PART NUMBERING

Sultan AW REMOTE ELECTRONICS

AWR2 Remote 2 Wire Housing/Facia Display Connection Board/Process Module, No relays
AWR234 Remote 2/3/4 Wire Housing/Facia Display Connection Board/Process Module, 5 relays
AWFR234 Remote 2/3/4 Wire Housing/Facia Display Connection Board/Process Module, 5 relays for Flow

HOUSING
S Standard polycarbonate electronics housing
P Panel Mount Housing

POWER SUPPLY
B 24 VDC standard
C 48 VDC for 2/3/4 units only
U Universal AC power supply (90-260 VAC input) for 234 units only

ADDITIONAL COMMUNICATIONS
S Switch only. 5 relays for AWR234 only
X 4-20mA analogue output module, includes Modbus comms
H HART 2 wire only
I HART Isolated 4 wire 2/3/4 only
W Modbus Comms only (not available for 2 wire Sultan)
P Profibus DP*
E Ethernet
D DeviceNet
Z Special Request

INTERNAL HAWKLINK MODEM (available with ATEX 0/20 approval)
X Not required
G2 GSM Frequency 800/1900 MHz/19200 Baud for USA,Canada,Chile,Argentina for Sultan 234 only
G4 GSM Frequency 900/1800 MHz/19200 Baud for Australia,Europe,Brazil for Sultan 234 only

APPROVAL STANDARD
X Not required
A0 ATEX 0 only for AWR2 (Areas II I GD IP67 Eexia II A T4) / IECEx Ex ia IIA T4 (Tamb -20C to +70C)
A22 ATEX Dust (Grp II Cat 3 D T85C IP67)
GP CSA   Equip Class 2, Pollution Deg.2, Measurement II (Ordinary locations)
RN CSA   Class I, Div. 1/2, Group D; Zone 0; AEx/Ex ia IIA; T4
KN CSA   Class II, Div. 2 Grp F&G; Class III

POSITION UNIT / CRANE MASTER SOFTWARE OPTIONS
PS Position Slave
CM Crane Master
X   Not required

AWR2	S	B	X	X	X	X

*Cannot be used with internal HawkLink, only with remote HawkLink.

PART NUMBERING

Sultan Remote Systems

Sultan AW Remote Transducer 3" and 3.5"

Model

AWRT	Acoustic Wave Remote Transducer

Transducer Frequency

30	30kHz for applications up to 15m for 3" (4" cone is recommended for 3" units)
20	20kHz for applications up to 20m, available in 3" only (4" cone is recommended)
15	15kHz for applications up to 30m, available in 3" only (10" cone is recommended)
10	10kHz for applications up to 40m, available in 3.5" only (10" cone is recommended)
09	09Hz for high power extended range applications up to 170m (10" cone is recommended)
05	05kHz for applications up to 60m maximum, available in 3.5" only (10" cone is recommended)
04	04kHz for high power extended range applications up to 170m (10" cone is recommended)

Process Temperature - Facing material selection

S	Standard Temperature Dry Atmosphere only, (Polyolfin face) for 4, 5, 9 and 10kHz only
T	Standard Temperature (Wet Atmosphere, 3" teflon face)
Y	High Temperature (Wet and Dry Atmosphere,150C, Titanium face) for 10KHz only
F	4" Full Teflon Face (for 30 and 20KHz Units only)
Z	Special Request

Transducer Housing Material

4	Polypropylene
6	For 3" Teflon please contact factory

Thread Standards for End cap

X	Not Required (Standard Flange Mount, see flange & cone selection)
TB	BSP
TN	NPT

Mounting Thread Sizes

X	Not Required (Standard Flange Mount, see flange & cone selection)
20	2" thread for 50,40,30 KHz in Tefzel housing only
30	3" thread on the back cap for 30,20,15 KHz only. For 15kHz use "B" type flange.
50	3.5" thread on the end cap for 10 and 5KHz only

Approval Standard

X	Not Required
A0	IECEx Zone 0 (Ex ia IIA T4) / ATEX (Grp II Cat 1 GD IP67 EEx ia IIA T4)
A1	ATEX Encapsulated (Grp II Cat 2 GD EEx m II IP68)
A20	ATEX Dust (Grp II Cat 1 D T85C IP67)
A21	ATEX Dust (Grp II Cat 2 D T85C IP67)
A22	ATEX Dust (Grp II Cat 3 D T85C IP67)
GP	CSA Equip Class 2; Pollution deg 2; measurement II (ordinary locations)
RN	CSA Class I; Div 1/2; Group D; Zone 0; AEx/Ex ia IIA; T4
KN	CSA Class Ii; Div 2; Group F & G; Class III

Connection

C	IP68 Sealed unit with cable

Cable Length

6	6m cable (Standard)
15	15m cable
30	30m cable
50	50m cable
X	Not Required

Mounting Accessories

X	Not Required
CS	Cable Suspension for remote 50/40/30/20KHz only

Software Options for Sultan 234

PS	Position Slave
FP	
F	Flow - Including multifit shading flange and fast temp compensation only available for 20, 30, 40, 50kHz
X	Not required

AWRT	30	T	4	X	X	X	C	6	X	X

PART NUMBERING

Sultan AW SMART TRANSDUCER

AWST **A** Sultan Smart, 2 wire 4-20 mA
  C Smart Acoustic Wave Transducer with Modbus, 1 relay
  D 234 Smart Acoustic Wave Transducer with modbus, 1 relay, 4-20mA

  TRANSDUCER FREQUENCY
  50 50kHz for applications up to 5m, available in 2" only
  40 40kHz for applications up to 7m, available in 2" only
  30 30kHz for applications up to 11m, available in 3"
  20 20kHz for applications up to 20m, available in 3" only *
  15 15kHz for applications up to 30m, available in 3" only*
  10 10kHz for applications up to 40m, available in 3.5" only
  09 09kHz for high power extended range applications up to 170m (10" cone required)
  05 05kHz for applications up to 60m maximum, available in 3.5" only
  04 04kHz for high power extended range applications up to 170m (10" cone required)

  PROCESS TEMPERATURE - Facing material selection
  S Standard Temperature (Dry atmosphere only, Polyolfin face)
  T Standard Temperature (Wet Atmosphere, teflon face)
  Y High Temperature (Wet and Dry Atmosphere, 150C, Titanium face) for 10kHz only
  Z Special Request

  TRANSDUCER HOUSING MATERIAL
  4 Polypropylene
  6 Tefzel for 2" (standard). For 3" Teflon please contact Hawk.

    THREAD STANDARDS
    X Not Required (see flange & cone selection)
    TB BSP (Viton O-ring supplied)
    TN NPT

    THREAD SIZES
    X Not Required (standard flange mount)
    20 2" thread gor 50,40,30 kHz only
    30 3" thread for 30,20,15 kHz only
    40 2" thread with 2" cone for 20kHz only

      APPROVAL STANDARD
      X Not required
      A1 ATEX Encapsulated (Grp II Cat 2 GD EEx m II IP68)
      A20 ATEX Dust (Grp II Cat 1 D T85C IP67)

      CONNECTION
      C IP68 Sealed unit with 6 metre cable
      CS above with suspension fitting
      S Screw top unit with M20 cable gland

        Cable
        6 6m cable
        15 15m cable
        30 30m cable
        50 50m cable
        X Not required (screw cap only)

AWST	A	50	S	4	X	X	X	S	X

APPROVAL STANDARDS

FM, SAA (Pending)

PART NUMBERING

Sultan AW INTEGRAL

AWI2 Intergral 2 Wire, Housing/Facia Display Connection Board/Process Module, No relays
AWI234 Intergral 2/3/4 Wire, Housing/Facia Display Connection Board/Process Module, 2 relays

HOUSING
S Standard Plastic Moulded Housing

POWER SUPPLY
B 24 VDC Standard
C 48VDC for 234 only
U Universal AC Power Supply (90-260 VAC input) and 12-30VDC, For 234 only

TRANSDUCER FREQUENCY
50 - 50kHz for applications 0-5m, available 2" only
40 - 40kHz for applications 0-7m, available 2" only
30 - 30kHz for applications up to 11m for 2" and 15m for 3" (4" cone is recommended for 3" units)
20 - 20kHz for applications up to 20m, available in 3" only * (4" cone is recommended)
15 - 15kHz for applications up to 30m, available in 3" only * (10" cone is recommended)
10 - 10kHz for applications up to 40m, available in 3.5" only * (10" cone is recommended)
09 - 09Hz for high power extended range applications up to 170m * (10" cone is recommended)
05 - 05kHz for applications up to 60m maximum, available in 3.5" only * (10" cone is recommended)
04 - 04kHz for high power extended range applications up to 170m* (10" cone is recommended)

PROCESS TEMPERATURE - Facing material selection
S Standard Temperature Dry Atmosphere only, (polyolfin face) for 4, 5, 9 10 and 15kHz only
T Standard Temperature Wet Atmosphere (teflon face)
Y High Temperature (Wet & Dry Atmosphere,150C, Titanium face) 10kHz only

TRANSDUCER HOUSING MATERIAL
4 Polypropylene, Standard 30, 20, 15, 5kHz (Large Housing)
6 Tefzel for 2" (standard). For 3" Teflon please contact us

THREAD STANDARDS
X Not Required (see flange & cone selection)
TB BSP
TN NPT

THREAD SIZES
X Not Required
20 2" thread for 50,40,30 kHz only
30 3" thread for 30,20,15 kHz only
40 2" thread with 2" cone for 20kHz only
50 3.5" thread on the back cap for 5 and 10 kHz only

ADDITIONAL COMMUNICATIONS
S Switch only. 5 relays for 2/3/4 only
X 4-20mA analogue outpout module, includes Modbus comms
H HART 2 wire only
I HART isolated 4 wire, 2/3/4 only
W Modbus comms only (not available for 2 wire)
P Profibus DP
E Ethernet
D DeviceNet
Z Special request

APPROVAL STANDARD
X Not Required
A0 ATEX 0 only for AWI2
A22 ATEX Dust (Areas II ID T85C IP67)

Position/CraneMaster Software Options
PS Position Slave
CM Crane Master
X Not required

AWI2	S	B	50	S	4	X	X	X	X	X

APPROVAL STANDARDS
CSA, FM, SAA (Pending)

PART NUMBERING

FLANGE SELECTION

FLANGE
F Flange Selection

DIMENSION STANDARD
A   ANSI
D   Din
J   JIS
Z   Special Request

FLANGE SIZES
2N   2" NPT flange
2B   2" BSP flange
3   3" acoustically isolated flange
4   4" acoustically isolated flange
8   8" acoustically isolated flange
10   10" acoustically isolated flange
Z   Special Request

FLANGE MOUNTING POSITION
A Cone Mounted
B Transducer Body Mounted
C Angle Flange

FLANGE MATERIAL
4   Polypropylene
6   Teflon
Z   Special Request

```
┌─┬─┬─┬─┬─┐
│F│A│4│A│-│4│
└─┴─┴─┴─┴─┘
```

LOCKING RING
LR
Not Required
4   For 4" and 6" flanges
8   For 8" cones for 15KHz
10 For 10" flanges/cones

Material
4 = Polypropylene

```
┌──┬─┬─┐
│LR│4│-│4│
└──┴─┴─┘
```

CONE SELECTION

CONE
C Focalizer Cone

CONE SIZE
02N   Adaptor for 2" NPT Sensor to fit into 4" cone (included)
02B   Adaptor for 2" BSP sensor to fit into 4" cone (included)
03   3" cone for 30,20 and 15kHz transducers with TB30 or TN30 threads
04   4" cone, 30 and 20kHz 3" transducer
08-15   8" cone,15kHz
08-10   8" cone, 10kHz
10-15   10" cone,15kHz
10-09   10" cone, 9kHz
10-10   10" cone, 10kHz
10-04   10" cone, 4kHz
10-05   10" cone, 5kHz

CONE MATERIAL
4   Polypropylene
6   Teflon
7   Carbon Fibre. Must be used with Carbon Fibre flange
7A   Carbon Fibre - comes attached to Carbon Fibre ANSI flange
7D   Carbon Fibre - comes attached to Carbon Fibre DIN flange
7J   Carbon Fibre - comes attached to Carbon Fibre JIS flange
8   Polyurethane*
Z   Special Request

```
┌─┬──┬─┐
│C│04│-│4│
└─┴──┴─┘
```

* Polyurethane can be compressed to fit into the next smaller nozzle mounting size, e.g.. 8" polyurethane cone will compress into a 6" nozzle and so is 10" poly-urethane in to 8" nozzle. Please confirm the maximum nozzle height allowed.

PART NUMBERING

Full **AW INTEGRAL ELECTRONICS**

ELECTRONICS	+	FLANGE	+	CONE	+	EXTRAS
AWI2SB20T4XXXXX		FA4A-4		C04-4		X

Full **AW REMOTE TRANSDUCER**

ELECTRONICS	+	FLANGE	+	CONE	+	EXTRAS
AWRT50S4XXXC6XX		FA4A-4		C04-4		X

Full **AW SERIES SMART TRANSDUCER UNIT**

ELECTRONICS	+	FLANGE	+	CONE	+	EXTRAS
AWSTA30S4XXXC6		FA4A-4		C04-4		X

Full **AW REMOTE ELECTRONICS**

ELECTRONICS	+	EXTRAS	
AWR234SUXXXX		X	**To be used with AW Series Remote Transducer**

Additional product warranty and application guarantees upon request.

Technical data subject to change without notice.

All company or product names are registered trademarks or trademarks of their respective owners.

For the latest updates go to www.hawkmeasure.com

SPECIFICATIONS

Frequency
• 4kHz, 5kHz, 9kHz, 10kHz, 15kHz, 20kHz, 30kHz, 40kHz, 50kHz

Operating Voltage
• 12 - 30Vdc (residual ripple no greater than 100mV)
• 90 - 265Vac 50/60Hz
• 48Vdc,48Vac-90Vac 50/60Hz

Power Consumption
• <3W @ 24Vdc
• <10VA @ 240Vac
• <4W @ 48Vdc, <7VA @ 48Vac – 90Vac.

Analog Output
• 4 -20mA (750 ohms @ 24Vdc User supply, 250 ohms internally driven)

Communications
• GosHawk, HART, Modbus, Profibus DP, DeviceNet, Foundation Fieldbus, Profibus PA. Multidrop mode can address 1-250 units over 4 wire

Relay Output
(2) Integral (5) Remote
• Form 'C' (SPDT) contacts, rated 0.5A at 240Vac non-inductive.
• All relays have independently adjustable dead bands.
• Remote fail-safe test facility for one relay.

Blanking Distance
• 50kHz   = 0.25 m (10")
• 40kHz   = 0.30 m (12")
• 30kHz   = 0.35 m (14")
• 20kHz   = 0.45 m (17")
• 15kHz   = 0.60 m (24")
• 10/9kHz = 1.0 m (39")
• 5/4kHz   = 1.5 m (59")

Maximum Range
• 5m (16ft)   50kHz liquids
• 7m (22ft)   40kHz liquids
• 10m (33ft) 30kHz liquids, 5m (16ft) solids
• 20m (65ft) 20kHz liquids/slurries, 10m (33ft) solids
• 30m (98ft) 15kHz liquids/slurries, 20m (65ft) solids
• 50m (165ft) 10kHz liquids/slurries/powders/solids
• 60m (196ft) 5kHz liquids/slurries/powders/solids
• 180m (588ft) 4/9 kHz for extended range

Resolution
• 1 mm (0.04") 50, 40, 30,20, 15, 10, 5kHz
• 4 mm (0.2") 9, 4kHz

Sensor Accuracy
• +/- 0.25% of measured range

Operating Temperature
• Integral System -40°C (-40°F) to 80°C (176°F)
• Remote electronics -40°C (-40°F) to 80°C (176°F)
• Remote transducer -40°C (-40°F) to 80°C (176°F)
-40°C (-40°F) to 175°C (Hi-Temp. version)

Transducer/Amplifier Separation
• Up to 1000m using specified extension cable

Cable
• 4 conductor shielded twisted pair instrument cable.
Conductor size dependent on cable length.
BELDEN 3084A, DEKORON or equivalent.
Max: BELDEN 3084A = 500m (1640 ft)
Max: DEKORON IED183AA002 = 350m (980 ft)
Maximum Operating Pressure
• +/- 7.5 PSI (+/- 0.5 Bar)

Beam Angle
• 7.5°   without focaliser   50kHz/40kHz/30kHz
• 4°   with focaliser   50kHz/40kHz
• 6°   with focaliser   30kHz/20kHz/
                             15kHz/10kHz/5kHz
• 10°   with focaliser   9kHz/4kHz

Display
• 2 line x 8 digit alphanumeric LCD

Memory
• Non-Volatile (No backup battery required)
• >10 years data retention

SPECIFICATIONS

Enclosure Sealing
• Integral System IP67
• Remote Electronics IP65 (Nema 4x)
• Remote Transducer IP68

Cable Entries
• Integral: 3 x M16 Glands
• Remote: 3 x 20mm, 1 x 16mm knock outs.

Mounting
• ANSI, JIS or DIN Flange
• 4 in/100mm to 10 in/250mm
• 2in BSP Thread / NPT Thread

Typical Weight
Sultan AW System with appropriate flange and cone
4 or 5kHz Transducer 13kg, 28.6lb
9 or 10kHz Transducer 10kg, 22lb
15kHz Transducer 8kg, 17.6lb
20 or 30kHz (3") Transducer 3kg, 6.6lb
30 (2"), 40 or 50kHz Transducer 1kg, 2.2lb

Configuration	kg	lb	R6
Remote system with 6m cable	1	2.2	
R15 Remote system with 15m cable	3	6.6	
R30 Remote system with 30m cable	6	13.2	
R50 Remote system with 50m cable	10	22.0	

IMPORTANT
"USE SPECIFIED CABLE ONLY"

SOUND VELOCITIES

Sound Velocities for Gases at 0°C

	Metres per Second	Feet per Second
Dry air	331	1086
Ammonia	415	1362
Argon	308	1010
Carbon Dioxide	259	850
Carbon Monoxide	338	1109
Chlorine	206	676
Dueterium	890	2920
Ethane (10ºC)	308	1010
Ethylene	317	1040
Helium	965	3166
Hydrogen	1284	4213
Hydrogen Bromide	200	656
Hydrogen Chloride	206	676
Hydrogen Iodide	157	515
Hydrogen Sulfide	289	948
Illuminating (Coal Gas)	453	1486
Methane	430	1411
Neon	435	1427
Nitric Oxide (10ºC)	324	1063
Nitrogen	334	1096
Nitrous Oxide	263	863
Oxygen	316	1037
Sulphur Dioxide	213	699

Sound Velocities for Vapours at 0°C

	Metres per Second	Feet per Second
Acetone	230	755
Benzene	202	663
Carbon Tetrachloride	145	476
Chloroform	171	561
Ethanol	269	883
Ethyl Ether	206	676

NOTE:

Speed of sound can vary with the medium through which the sound pulse travels. The Sultan is set for Dry Air at 331m/second. To change the Velocity .

HAWK MEASUREMENT SYSTEMS

PTY. LTD.   A.C.N. 006 782 449

15-17 MAURICE COURT
NUNAWADING VIC. 3131
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VIC. 3131 AUSTRALIA
EMAIL: HawkSales@hawk.com.au
PH: +61-3 9873 4750
FAX: +61-3 9873 4538   (Sales/Engineering)
FAX: +61-3 9873 4384   (Accounts/Production)

DECLARATION OF CONFORMITY

Manufacturer's Name:	HAWK MEASUREMENT SYSTEMS PTY LTD
Manufacturer's Address:	15–17 Maurice Court Nunawading, Vic. Australia 3131
declares that the product	SULTAN Series Acoustic Wave Level Transmitter
Models	AWI2, AWI234, AWR2, AWR234, AWRT, AWIH2, AWIH234, AWRH2, AWRH234, AWRTH, AWSTHA, AWSTHB, AWSTHC and AWSTHD.

conform to the following product specifications:

Low Voltage Directive:	73/23/EEC
Amendment Directive:	93/68/EEC
EMC Directive:	89/336/EEC
ATEX Directive:	94/9/EEC

Standards in whole or in part to which conformity is declared:

Normative Documents:	EN 61326: 1997 +Amendment 1: 1998 + Amendment 2:2001 EN 61010-1:2001 EN 50014:1997 +Amendments 1 & 2:1999 EN 50020:2002 EN 50028:1987 EN 50281-1-1:1998 EN 50284:1999

Standards:	IEC 1000-3-2: 1995	IEC 1000-4-4: 1995
	IEC 1000-3-3: 1994	IEC 1000-4-5: 1995
	IEC 1000-4-2: 1995	IEC 1000-4-6: 1996
	IEC 1000-4-3: 1995	IEC 1000-4-11: 1994

Supplemental Information:

Under ATEX Directive 94/9/EC, the above models have been certified by Intertek. These products comply with the requirements of Low Voltage Directive 73/23/EEC, Amendment Directive 93/68/EEC, and EMC Directive 89/336/EEC, and carry the CE-marking accordingly.

Signature:	*Colin Prohasky*
Name:	Colin Prohasky
Position:	Engineering Manager
Date:	9 August 2006
Place:	Melbourne, Australia.

Certificate of Compliance

EMC Technologies Report No: M030826
Issue Date: 6th January 2005

Test Sample:	Sultan Series Acoustic Wave Level Transmitters
Model:	AWR234SUMX (Remote) and AWI234SU30STB20MX (Integral)
Manufacturer:	Hawk Measurement Systems Pty Ltd
Address	15-17 Maurice Court (PO box 286)
	Nunawading, Vic 3131
Phone:	(03) 9873 4750
Fax:	(03) 9873 4538
Contact:	Colin Prohasky (Engineering Manager)
Web site:	www.hawklevel.com
Tested for:	Hawk Measurement Systems Pty Ltd
Address:	15-17 Maurice Court,
	Nunawading VIC 3131 Australia
Phone:	+613 9873 4750
Fax:	+613 9873 4538
Contact:	Colin Prohasky
Email:	colin@hawk.com.au

Test Standard: ***EN61326: 1997, Amendment 1: 1998 and Amendment 2: 2001**
Electrical equipment for measurement, control and laboratory use –
EMC requirements

Result of Test: **The Test Sample complied with the above Standard. Refer to Report M030826 for full details**

Test Dates: 23rd September 2003 – 25th August 2004

Test Officers:

Janath Gunasekera   Steven Kolar

Authorised Signature:

Petra Hansen
EMC Technologies Pty Ltd

*EN61000-3-2 Current Harmonics and EN61000-3-3 Voltage Flicker tests referenced in EN61326-1 are not within the current scope of NATA accreditation.

Issued by EMC Technologies Pty. Ltd., 57 Assembly Drive, Tullamarine, VIC, 3043, Australia.
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Latest version on www.hawkmeasure.com

Contacts

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